ATLANTIC FISHERIES
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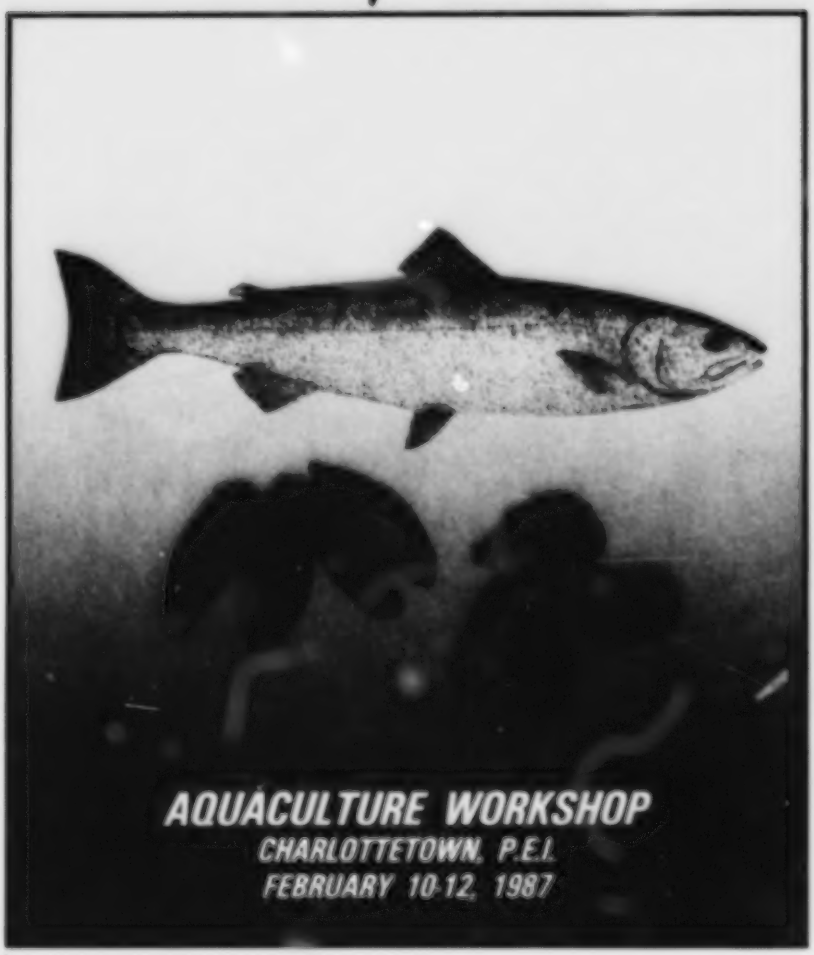

Canada

Fisheries and Oceans / Pêches et Océans

ATLANTIC CANADA AQUACULTURE WORKSHOP

Charlottetown, Prince Edward Island
February 10-12, 1987

SPONSORED BY:
The Atlantic Fisheries Technology Program (AFTP)
Department of Fisheries and Oceans

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ABSTRACT

Roache, J. F. (ED.). 1987. Atlantic Canada Aquaculture Workshop - Proceedings. General Education Series #5; Vol.I; 229p.; Vol.II; 191p.

This publication contains the proceedings of the Atlantic Canada Aquaculture Workshop held in Charlottetown, Prince Edward Island, February 10-12, 1987. Sponsored under the Atlantic Fisheries Development Program of the Department of Fisheries and Oceans, the Workshop brought together by invitation approximately 175 resource persons and participants representing two levels of government (federal and provincial), the aquaculture industry and several research institutes from across the region. While the fundamental purpose of the Workshop was to serve as a technology transfer exercise, an equally important objective was to develop a consensus among participants concerning the future direction of research and development and related initiatives within the salmonid, mussel and oyster sectors of the industry in Atlantic Canada.

RESUME

ROACHE, J.F. (ED). 1987. Atelier Atlantique sur l'Aquaculture. Education générale. Série no. 5; Vol.I; 229p.; Vol.II; 191p.

Cette publication comprend les Actes de l' Atelier Atlantique sur l'Aquaculture, qui s'est tenue à Charlottetown à l'Ile du Prince Edouard du 10 au 12 février 1987. Parrainée par le programme de technologie des pêches de l'Atlantique, Ministère des Pêches et Océans, l'atelier a réuni sur invitation environ 175 experts et participants représentant deux niveaux du gouvernement (fédéral et provincial), l'industrie aquicole et les instituts de recherche de la région. Tandis que l'objectif principal de la conférence a consisté en un exercise de transfert de technologies, un autre, d'egale importance, a visé l'établissement d'un accord parmi les participants en ce qui concerne l'orientation future de la recherche et du développement ainsi que des initiatives connexes au sein des secteurs des salmonides, moules et huîtres de l'industrie du Canada Atlantique.

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NOTICE

The opinions and presentations are strictly those of the authors and not necessarily those of the Department of Fisheries and Oceans, or the Government of Canada.

INTRODUCTION

On February 10-12, 1987, the Department of Fisheries and Oceans (DFO), in co-operation with the Conference Bureau at Prince Edward Island's Holland College, hosted an Atlantic-wide, industry-government Workshop on Aquaculture. Another milestone in technology transfer under the Atlantic Fisheries Development Program, the Workshop was the second in a series to be sponsored by the Department during the first quarter of 1987.* It brought together, despite one of the worst winter storms of the season, approximately 175 delegates from all across the five Atlantic provinces. Included, in addition to aquaculturists from the salmonid, mussel and oyster sectors, were representatives of the research, education and training establishments and of both levels of government - federal and provincial.

The Atlantic Canada Aquaculture Workshop was really a three-in-one proposition. In addition to plenary, luncheon and dinner sessions involving all participants, separate sessions for each of the different sectors were held simultaneously over much of the three-day period. The Workshop had among its objectives to:

- provide a forum for exchange of new and appropriate technologies for aquaculturists in Atlantic Canada;

- obtain feedback from aquaculturists with respect to their needs, problems, and development constraints;

- assist in determining future research and development priorities geared toward better resource enhancement; and

- seek new directions for expansion of the aquaculture industry in Atlantic Canada.

* Note: The other two workshops in the series include one on Surimi Development, held in Clarenville, Newfoundland - January 28/30, 1987 and one on Technology Transfer in Grande Rivière, P.Q. - March 9/11, 1987.

In announcing the Workshop, Fisheries and Oceans Minister Tom Siddon said: "This Workshop could not be more timely given that the Department is currently negotiating agreements affecting the commercial development of aquaculture with the various provinces....The time has come for us to pause, to take stock of recent developments, to compare experiences and to map out a strategy to allow us to take full advantage of the opportunities available through aquaculture." The Atlantic Canada Aquaculture Workshop, then, was intended as the DFO contribution to the ongoing process of defining a rational development strategy for this expanding segment of the industry.

At present, aquaculture in Atlantic Canada generates approximately $9 million a year in total revenues. The potential exists to increase the value of these fisheries by as much as 30 times within the next decade. Salmon farming in the Bay of Fundy area, for example, has grown in value tremendously in recent years. The market for cultured mussels, meanwhile, appears very promising; the rate of new entrepreneurs entering the sector continues to increase rapidly to meet a growing demand. And oyster production, while subject to environmental constraints and seed shortages in certain areas, shows every indication of achieving its former levels of productivity.

The objective of an efficient, profitable industry has two dimensions. The first is the research effort, which is well in hand in Canada. The second is the development effort -- the transition from the experimental setting to the commercial environment, which remains an area of great potential. It is here that the Atlantic Fisheries Development Program, other government agencies and programs, and entrepreneurs from throughout Atlantic Canada can make a great contribution. Aquaculture will only mature as an industry when development-oriented entrepreneurs match the lead already established by the scientific community.

Commercial aquaculture draws from the scientific community a variety of benefits ranging from research and development in such fields as fish health, disease prevention and control, nutrition and diet formulations, genetics and stock selection, growth and reproductive physiology, and the optimization of biological systems. The development community will continue to provide technology-related R & D, technical information and advice, and selective capital assistance. However, a development strategy must emerge, and this was, in fact, the rationale behind the Department's convening the Atlantic Canada Aquaculture Workshop.

Mussels - Considerable emphasis was placed during the mussel culture sessions on three major areas of concern to growers:

- carrying capacity per leased acre/hectare;
- post-spawning mortality;
- monitoring programs for growers.

Carrying Capacity - In some areas of Atlantic Canada 75-80 per cent of the area suitable for mussel culture is already committed. Over-crowding could become a problem; carrying capacity will dictate future productivity increases under such circumstances. There is a need for greater effort on the part of biologists and technologists within the department and the research institutes to explore this potential problem. An educational program for growers should then be used as a vehicle to make the resulting information available to growers.

Mortality - Rates as high as 25-50 per cent have been observed in certain parts of Atlantic Canada, seriously impeding economic viability within the sector. Research has been sporadic and unco-ordinated to date; growers are experiencing difficulty in obtaining information. It was suggested that, by way of response, a responsibility centre, supported by an operational data base, be established in the Region.

Monitoring Program - Productivity is often the result of environmental factors of which growers have insufficient knowledge and over which they have inadequate control. There are many unanswered questions in this regard. The issue is whether it is government, the research institutes or the growers themselves who must provided the answers. The consensus seemed to be that it is a grower responsibility, but that they must be helped through the provision of an educational program. Such a program would help them monitor environmental indicators and modify their individual operations on that basis. Such a program was deemed feasible and an investment in the order of $1,500 would be all that is required to provide growers the necessary technical capability.

Other topics of discussion centred on marketing problems (misrepresentation of wild mussels as cultured); the need to streamline leasing procedures; possible diversification into other species (scallops, quahaugs, etc.); and the potential for secondary-level product development. All have obvious implications for the Department.

Oysters - Current oyster production of about 5 million pounds is concentrated in the southern Gulf of St. Lawrence and is directed at the "half-shell" trade. This level of output is approximately one-third of the historical maximum; the immediate objective of the industry is to again produce around 15 million pounds of product annually. This will be achieved through:

1. the enhancement of public beds, and

2. the development of private leases.

At issue is which of the two methods is preferable from the point of view of cost effectiveness, probability of success, level of public assistance required, and the effect on quality of bottom versus off-bottom rearing techniques. The advantages/disadvantages of the various methods of spat collection also came in for considerable discussion.

The Atlantic Fisheries Development Program, therefore, has an important role to play, together with industry and other government agencies in three distinct facets of an evolving aquaculture strategy:

- the transfer of already-established commercial technologies and techniques to Canada from abroad;

- research and development programs to create indigenous commercial technologies; and

- technology transfer and industrial training programs to ensure that the latest information and know-how is diffused throughout the industry in Atlantic Canada.

But all of the organizations -- federal, provincial, institutional and private sector -- represented at the Atlantic Canada Aquaculture Workshop have an important job to do: to ensure that this burgeoning industry comes to fulfill its obvious potential -- quickly, efficiently and effectively.

The quantity of material is such that these Proceedings are presented in two separate volumes. Volume I contains the Mussel/Oyster presentations and related material. Volume II is devoted strictly to salmonids. They can, therefore, be reviewed individually or as a set, subject to the specific inclinations of the reader.

About 175 participants from industry, government and the research institutes from throughout the Region attended the Atlantic Canada Aquaculture Workshop in Charlottetown, P.E.I., February 10-12, 1987. This was the Opening Session (Plenary) in which the RDG, Gulf Region, addressed participants, substituting for Pat Binns, Parliamentary Secretary to the Minister of Fisheries and Oceans.

The RDG, Gulf Region, Eugene Niles (above) introduced Peter Hjul (below), Publisher, Fish Farming International, guest speaker for the Banquet. Mr. Hjul spoke on "International Aquaculture". Head table guests for the occasion were representative growers from each of the five Atlantic provinces.

OPENING ADDRESS

by

Eugene Niles

Director General, Gulf Region, Fisheries and Oceans

(on behalf of Fisheries and Oceans Minister,

the Hon. Tom Siddon

and

the Minister's Parliamentary Secretary,

Pat Binns, M.P.)

I welcome you to the first comprehensive Workshop on Aquaculture for Atlantic Canada. We have here today about 130 aquaculturists, along with representatives of schools and universities, and federal and provincial governments. In this room are the pioneers of a new Atlantic industry. We will be joined by others for tomorrow's sessions.

At this Workshop, you will exchange information. You'll discuss the tricks of the trade. You'll talk about future directions for government and industry. And you'll try to come up with some new keys to success -- for each of you and for the industry in general.

What are the secrets of success? You're the experts on the technical side. But maybe it's worth taking a quick look at the underlying factors that give technology a chance to work.

Atlantic Canada would seem the perfect place for aquaculture to take off. The seacoast swarms with life. We've got hundreds of unpolluted bays and thousands of miles of shoreline for aquaculture. We're in a well-off, well-educated, industrialized country, and we're next door to the world's single greatest market for quality fish.

But given the past record of Atlantic aquaculture and the Atlantic fishery in general, we could well ask ourselves a few questions. How long will the present growth continue? Will we cope with competition from overseas and in the United States? Will we develop the quality and service, the associated businesses, the whole industrial structure that builds a world reputation and attracts world business?

Our long-term success is far from being a simple matter and far from being certain. In thinking about our own future, perhaps we should glance at the way in which aquaculture developed in other countries.

Probably the best-known success stories are those of Norway and Japan. In the last 10 or 15 years, Norway has moved from almost zero production in Atlantic salmon to perhaps 35,000 tonnes, with future projections of 100,000 tonnes. That's far above the normal catch by our own huge fleet of four or five thousand vessels fishing wild salmon on the Pacific. Over 500 Norwegian salmon farms now employ more than 2500 people, most of them doing well for themselves.

What did Norway have going for it? In the first place, good resource and environmental conditions, a fish-rich coast and ice-free fjords.

But if aquaculture fits Atlantic Canada so naturally, why have we been slower getting started than certain other nations? And why did a number of our earlier attempts end in failure?

A hundred years ago, the federal Department of Fisheries set up dozens of hatcheries across the country, for salmon and other species. People were hypnotized by hatcheries. Fish culture seemed to be the secret of abundance and prosperity. But by the 1930's, scientists found that the hatcheries had made little difference, and many of them faded away.

Since then, the world has learned a lot more about aquaculture - about diets, about health protection, and about handling the different species. Canadian biologists and engineers made an important contribution. By the end of the 1960's, we had a much greater knowledge base. Accordingly, in the 70's, several large pioneering ventures started up on both the Atlantic and Pacific coasts -- only to collapse, for a variety of reasons. So, too, did a number of small ventures.

But people kept pressing on, and today aquaculture looks promising. For example, mussel farming on Prince Edward Island and salmon farming in southern New Brunswick are now doubling production every year.

Business conditions also helped. Although Norway has only a small population, it has a strong marine and fisheries infrastructure - the boat-builders, net manufacturers, and associated industries to develop and maintain marine technology. Norway also has good transportation, a strong business community, and the markets of Europe nearby.

Besides good environmental and business climates, Norway had the right people doing the right things. The Norwegians began with a high regard for fish. They handle it with care and appreciate its value. Their tradition of trout culture made it easy for them to switch to salmon culture. The Norwegian government aided salmon farmers with research, selective breeding, provision of eggs and smolts, and general encouragement.

Norway, however, had its own failures in salmon farming; but the entrepreneurs kept at it. They found out what worked. They set up a fish-farmers' sales organization and a smooth system of transportation and marketing. And, in the last 10 years, they have created one of the world's great success stories in aquaculture.

How about Japan? The Japanese successfully culture salmon, scallops, seaweed, you name it. They, too, had a rich sea with the right environment. As for the business environment, Japan has a large population and an

insatiable demand for fish. Again, the infrastructure was in place, including everything from transportation to traditions of entrepreneurship, and a strong network of fishing co-operatives along the coast. Also, Japanese companies tend to work together on new developments.

Like the Norwegians, the Japanese started with a high regard for fish and its value, and a tradition of husbandry. Over the decades, the Japanese made a special effort to import, absorb, and re-develop aquacultural methods. The government carried out extensive research, and also maintained a large network of experimental stations to try out new fishery methods. They kept at it until aquaculture began to click. Now, they are the world leaders.

How does Canada compare with these two countries? Our Atlantic coast has loads of fish, but, in some ways, the environment is worse. We face the great enemy of winter. Cold water slows fish growth. Ice destroys nets and pens.

So, what is the key to success? Everyone acquainted with aquaculture keeps coming back to the same point. A good natural environment helps. A good business environment helps. But, just as in Norway and Japan, in the end, it's the people that count, the entrepreneurs themselves and the people in government and industry who work with them.

Depending on the people, aquaculture can fail, even when surrounded by rich waters. Or it can succeed, even when starting with nothing except energy and an idea (like the catfish farmers in the United States, for example).

So what are we, as Canadians, doing to match our competitors? In fact, we have done a lot.

On the government side, our researchers have learned a great deal about how the fish live and how to keep them alive. Indeed, the Norwegians have learned a few things from us. To put our research knowledge to work, federal and provincial governments have published, they have preached, and they have undertaken many pilot projects.

Aquaculture in Atlantic Canada has tended to develop where the federal or provincial governments, usually both, were putting forth a strong effort. Examples include the salmon farms in southwest New Brunswick near the St. Andrews Biological Station, the mussel and oyster farms in eastern Nova Scotia, and shellfish and finfish culture on Prince Edward Island. The federal-provincial ERDA agreements on fisheries have helped greatly. So has the work of DFO's Atlantic Fisheries Development Branch, and that of the provincial agencies.

Projects in every province have emerged from government-industry co-operation, and government contracts have assisted private-sector research. Besides cross-fertilization of fish, there's been cross-fertilization among government and industry people.

The entrepreneurs themselves have made things work in the water. They've coped with wind, waves, ice, and the sometimes seemingly inexplicable demands of bureaucracy.

Here again, the federal Department of Fisheries and Oceans is trying to help. We have made an agreement with Nova Scotia, and we are negotiating agreements with other provinces for a simpler system. The intent is to have the provinces deal with most of the day-to-day administration, and thereby give aquaculturists faster service on licences.

Canadians in government and industry have indeed done a lot, and it shows in the statistics. As I noted, salmon production in southern New Brunswick is doubling yearly. More than two dozen farms have started up. Last year, they produced four or five hundred tonnes, worth perhaps $5 million. This year, the total could exceed $10 million.

In Nova Scotia, more than 50 "fish-farmers" grow mussels. More than a dozen grow European oysters. On Prince Edward Island, the mussel industry is overtaking the oyster industry, and starting to provide a good living to entrepreneurs. Scallops in Newfoundland, trout in Quebec -- every province has entrepreneurs who are starting to make a living from aquaculture, and rapid growth is continuing.

So we've come a long way, but we have a long way to go, with a lot of worries en route. We face strong competition from other countries, and we face special problems at home. Remember the things that weakened our wild-fish industry for so many years -- distances, isolation, fragmentation, problems of communication and co-ordination, and lack of responsiveness to the market. Will those same old problems haunt aquaculture? Or will you work to overcome them from the start?

As the lead federal agency for aquaculture, DFO, led by the Minister, the Honorable Tom Siddon, has consulted extensively with provincial governments during the past year. This has led to a consensus on aquaculture development. We are increasing federal co-operation to ensure development that is orderly and complementary to the wild fishery. Both levels of government will work together to encourage more production, higher value, reliable supply, and a strong, stable, technologically-advanced industry. The Premiers and Prime Minister have strongly endorsed aquaculture development.

But, for the most part, our government likes to let industry take the lead, while we act as a facilitator, providing support in some key areas such as research. We have increased consultation in every phase of the fishing industry -- lobster workshops, scallop workshops, technology workshops, new advisory systems, you name it.

With our belief in aquaculture and our belief in consultation, we have a double reason to take this Workshop seriously. And you, as pioneers, have a chance in this Workshop, and outside it, to put your own stamp on the future, shaping attitudes, forming directions for government and yourselves, and building well from the beginning.

I believe that you have the potential to make a good beginning. Except in the oyster industry, unlike the Norwegians and Japanese, you had little tradition of aquaculture on which to build. Yet, you have managed to make things work -- notwithstanding the lack of experience and notwithstanding some special problems unique to Canada.

You are pioneers and you have the nature of pioneers. You look outside your own locality, you gather knowledge from elsewhere, you try new ways of doing things, and you persevere until everything comes together and works right.

To make the aquaculture industry grow, you will have to apply that same approach on a wider scale. Because of the nature of the Atlantic coast, communications and coordination are always going to be special problems for you, just as they have been in the wild fish industry.

At this Workshop, you will, as I mentioned, exchange tricks of the trade amongst yourselves. But you also have a chance to think about the whole industry, and how the parts fit together.

Atlantic aquaculture is still really just getting started. Its future course is still unclear. And it is you, not government, who will do most to shape that course.

You can think about passing on your expertise to others, as eventually you will have to do, if we're to have a strong industry. You can think about all the ways to create more production, steadier channels of supply, top quality, good marketing, and strong associated businesses. You can

think about the co-ordination, the communication, and the critical mass that a strong industry must have. And in so doing, you have the potential to make Atlantic Canada the most diversified and flourishing aquaculture centre in North America.

So to conclude, at this first comprehensive Workshop on Atlantic Aquaculture, you have more to think about than growing fish. You need to think about growing an industry. And the main key to success for that industry, now and for years to come, is you, yourselves.

INTERNATIONAL AQUACULTURE

by
Peter Hjul
Editorial Director,
Fish Farming International
London, England

The farming of fish, molluscs, crustaceans and seaweeds is estimated to produce between 9 and 11 million tons of food a year. There is no precise figure because aquaculture has yet to inspire the attention which statisticians have been giving the traditional fisheries.

The Food and Agriculture Organization (FAO), a few years ago, calculated an annual farm harvest of around ten million tons. But only a few months ago we were caught up in an argument between FAO and an international research and development organization in the Far East. One of its economists queried figures given to the FAO by China and India. He suggested the figure for China was an overestimate of 131 per cent and that for India, 502 per cent. Both parties appear now to have settled their differences and I mention the argument only to give you an example of how much we can diverge in establishing production figures.

FAO does compile a much more reliable set of figures for overall aquatic production, including fish farming. Its world total for 1985 was just over 85 million tons. Last year may well have seen an increase to around 87 or 88 million tons. Assuming about 11 million tons for all farmed species, plus seaweeds, we find that aquaculture is at present providing 13 per cent of all aquatic production.

Not so many years ago, we had confident predictions that the fish supply at the turn of the century would comfortably exceed the 120 million tons a year necessary to maintain the seafood share of the worldwide protein diet. With the demand for fish growing and, we trust, dietary standards

improving, the demand by the year 2000 should be considerably more than 120 million tons. But, without some momentous discovery of new stocks or a remarkable breakthrough in farming, the aquatic harvest by 2000 is likely to be well short of that. It may be around 110 million tons.

Within this total, the tentative estimate for aquaculture is 22 million tons. This was made last year by Dr. Colin Nash, who heads the Aquaculture Program in the FAO. He was trained in the hard school of British marine farming, has worked in warm and coldwater aquaculture, and is not given to wild gazes into crystal balls. He qualified his estimate by saying that molluscs and seaweeds would account for a substantial share of the harvest; so, too, would culture-based fisheries enhancing natural resources in the open sea, in lakes, and in rivers and reservoirs. Ranching and fishery enhancement will play an increasing role in boosting traditional supplies. Much of the technology will emerge from farm work on hatcheries, feeding and disease; and I hope fishermen will take note of this when they feel threatened by aquaculture developments.

Assuming we reach 22 million tons, aquaculture will then enjoy a 20 per cent share of total production. We should remember this when next we are told that fishing is finished, and that the future belongs to farming.

Fishing is far from finished. As our knowledge of stocks has progressed and, as governments have established more protection, I believe that, overall, we are improving the resource. In many countries, including yours and mine, our fisheries are generally in a much better state now than they were 10 years ago. We can expect them to remain so. Farming, therefore, is a useful addition to our seafood supply, but with some notable exceptions, it is <u>no</u> substitute.

One exception, of course, is in the production of some salmonids. Another is the channel catfish in the U.S.A. We must also include the farming of mussels and oysters, which is proving a better and more reliable source of these seafoods than does gathering them from the wild. With the

spread of scallop culture from Japan, we might also eventually place these among the species better supplied from farms than hunted in the wild.

Then, there is the tropical prawn. The world supply of prawns or shrimp from all areas, cold and warm, now amounts to about 1.8 million tons a year. The coldwater prawn or pink shrimp is a slow-growing small animal and is not likely, for a long time, to be a candidate for farming. But the tropical penaeid prawn can yield two or more crops a year. It has long been a traditional farm product in Southeast Asia. Most farming has been in vast ponds in estuarial or paddy areas, using natural fertilization and with stock obtained by collecting wild post-larvae.

This culture gives 300 to 500 kg per hectare and accounts for most of some 120,000 to 130,000 tons of tropical prawns a year from farming. But the prawn-fishing countries are -- almost all of them -- reaching the limit of safe exploitation of natural stocks. For many, farming is the only way they can increase supplies to meet steadily rising demand.

There is also a constraint on farm expansion based on wild seed (or even spawners) and natural feeding. Intensive culture is coming into prawn farming. Hatcheries are being set up in Ecuador, Taiwan, India and several other countries. This is an evolving technology and is set to become perhaps the most important development in aquaculture over the next decade. By 1987, the prawn may well have passed the Atlantic salmon as the most valuable species in aquatic farming. Farm totals of 400,000 tons and more are already being confidently forecast. They may even go comfortably past this, if hatcheries and feed suppliers support intensive farming with yields of two or three tons/ha and two crops a year.

But it is the Atlantic salmon that is setting the pace in aquaculture in northern Europe. Much of this Workshop concerns the technology and economics of this remarkable development.

To bring you up to date, the Norwegian industry in 1986 exceeded all expectations, producing a record 45,500 tons of salmon and 4,000 tons of sea-grown trout. The value of this harvest, from some 600 farms, was the equivalent of $340 million, putting farmed salmon far above cod and shrimp as the most valuable species produced by the top fishing nation in Western Europe.

Add to this harvest, about 9,000 tons from Scotland and about 2,000 tons from Ireland, Iceland and the Faroes, and we have a 1986 production of more than 56,000 tons. Farm production of sea-grown and portion-sized freshwater rainbow trout in the whole of Europe is estimated at about 190,000 tons a year.

Within the world total, these figures may seem relatively small, but they represent enormous value for industrial-scale, intensive aquaculture. These are the money crops which attract the investment, stimulate the technology and, unfortunately, arouse the resentment of those forced to watch on the sidelines as farms spring up and cages dot once-uncluttered coastlines. The very success of farming is bringing its own penalties, not the least of them, the problem of selling the harvest and maintaining prices on which costs were based when the farms were started.

Only last week I was told at the International Food Exhibition in London that Norwegian salmon could be bought on the Billingsgate market, if it was taken in some volume, for well below $2 per pound. When you have fish in your cage, and it has been there for two years or so, you need to sell it. This rush to market has tended to take place towards the end of the year, and the gluts and the lower prices reflect the influence of "salmon success". After all, before farming, the wild Atlantic salmon catch was between 8,000 and 10,000 tons a year.

This year the organizations serving Norwegian farmers say the increase will slow down, to about 8,000 tons for a total of 53,000 to 54,000 tons. But until a few months ago, the 1986 total was expected to be about 40,000 tons. For some time, Norwegian farmers suffered from a shortage of smolts, but greater hatchery capacity may upset forecasts of slower growth.

Scotland should produce 14,000 to 15,000 tons in 1987, and we could see 8,000 tons from Ireland and other countries. From Europe alone, therefore, the 1987 salmon crop could be around 65,000 tons.

With increasing hatchery capacity, more farms and higher output from existing farms, Norway could be producing about 75,000 tons in 1988. Scottish production may then be about 20,000 tons and we could expect another 10,000 tons from other countries, for a total of more than 100,000 tons!

The industry is thus well on course for a 1990 production of more than 120,000 tons and possibly nearer to 150,000 tons. A market study in Ireland last year indicated this could be 20,000 tons more than expected demand. If so, prices must tumble if the fish is to sell and find new outlets. This, in turn, must force the less efficient farms out of business, but I doubt if it will seriously cut production.

As the Irish study observed, until now, salmon has not been eaten primarily to satisfy hunger. It is a prestige commodity. But at the price of cod or below, salmon is going to have to capture a different market. This fish will move off the table of the gourmet to become an available, reasonably priced dish for everyone who can now afford a steak, a cod fillet or even a fish stick.

This, in my view, will be one of the fish farmer's greatest contributions.

Where can we expect the Atlantic salmon increase to stop? Only a few years ago, 100,000 tons was thought to be a far-away limit. The Irish study sees the technical maximum as 250,000 to 300,000 tons for Europe. One obvious limiting factor is the supply of feed required in intensive farming.

At a conversion rate of two tons of feed to a ton of harvested fish, 1986 production will have used about 110,000 tons. These feeds average about 60 per cent fish meal, or 66,000 tons. And, at the usual reduction rate, that meal came from a catch of 330,000 tons of capelin, herring and other fish.

This is a figure worth remembering when the traditional fishery next hits out at aquaculture or tries to curb its growth. Far from being a competitor to most fishermen, aquaculture could be one of their best outlets for surplus fish.

Feed manufacturers are playing their own vital part in the development of aquaculture. From a small adjunct to their other supply activities, it has grown into a prime market for companies with the foresight to provide for its special requirements.

With trout farms an even bigger consumer than salmon farms, we can expect the demand from salmonids alone to exceed 600,000 tons in Europe within a few years. While soya meal and some other protein sources may make progress, I cannot see the fish base being substantially eroded.

On a quick calculation, therefore, about 350,000 tons of fish may be needed for aquaculture, and that will have to come from 1.75 million tons of raw material. Take it a step further to 300,000 tons of salmon and 200,000 tons of trout, and the 600,000 tons of meal in a million tons of feed will require a catch, for farming alone, of three million tons.

Advances in technology will, no doubt, improve feed conversion rates, and we will get fish substitutes. But I can see fishermen and fish farmers linked together for many years to come, as supplier and consumer.

One of the less-publicized reasons why Atlantic salmon farming has progressed so rapidly is that the diseases once expected to afflict growers and hatchers as they produced more and more fish have proven far less devastating than feared. There have been some problems with furunculosis, and the Norwegians have had to combat Hitra disease. But overall, farmed salmon have proved to be remarkably healthy and resilient animals.

This should not lull us into a complacent illusion of security, however. We, after all, are taking a wild carnivorous animal out of its natural environment; we subject it to the stresses of closed environment; and we vastly increase the progeny from a limited genetic base. It could all blow up in our faces. It has not done so, and we are fortunate.

The Norwegians are now working to reduce the risk by setting up a selective breeding program for salmon and trout. From being a wild creature in danger of extinction, the Atlantic salmon is now on its way to becoming domesticated, and selective breeding will help this process.

Another feature of industrial-scale aquaculture is the technology it is stimulating. In only 15 or so years, aquatic farming in many parts of the world has evolved from a cottage-type, hands-on activity to a sophisticated, highly-technical operation. There has been marked progress in farm engineering, in structures, and, most recently, in computer-assisted monitoring and control of farms. This was made strikingly evident at a conference in Trondheim last year when speakers described complete systems run by one or two people from a control console.

Where labour is in short supply and expensive, as in many parts of Norway, this may be the way to go. But in the highlands and islands of Scotland, in Ireland and, I am sure, in parts of Canada, the fish farm has an additional role -- it provides jobs where they are scarce. We should, therefore, look carefully at our techniques, and train young people, not only to cope with the higher levels of management, stock health and biology, but also to serve as skilled farm workers.

Finally, as farming expands, those developing the industry need to consider how it will fit into their communities, the ecologies, and the physical environments of its site locations. A few farms in a large rural area may merge into the landscape, and not be specially noticed. Dozens of farms present serious problems.

In Scotland, for example, the Scottish Scenic Trust recently pointed out that half of some 300 fish farms in the country are in unspoiled areas hitherto enjoyed by local residents and visitors. Where once existed beautiful scenery, abundant wildlife and tranquility, some $60 million in public money had been spent on fish farming without a plan. Left unchecked, such expansion will be met with increasing resentment and opposition. In many parts of Europe today, fish and shellfish farmers are being urged by their associations and pushed by governments to be good neighbours.

In some cases, this may slow development. But in the long term, it can only benefit aquaculture and ensure it takes and holds its rightful place as a food supplier of increasing importance and as a responsible and caring member of the international fishing industry.

SECTION I

MUSSEL CULTURE

Assistant Deputy Minister Atlantic, Bill Rowat, delivers Opening Remarks to 90 participants during the Mussel Culture Session of the Atlantic Canada Aquaculture Workshop.

OPENING REMARKS

by

Bill Rowat
Assistant Deputy Minister, Atlantic
Fisheries and Oceans
Ottawa, Ontario

Mussels have been cultured in Europe for at least 100 years, but it is something quite new, certainly to Atlantic Canada, and to most of North America. Most people are aware that it was only during the mid-1970's that mussel culture was given its tentative start here on the Island. Irwin Judson was one of the people associated with those early efforts a mere 10 years ago. There were many pilot projects on P.E.I. and, in those days, the New Brunswick Department of Fisheries was the only other government agency involved.

By the early 1980's, we had our first commercial growers. On the Island, Joe VandenBremt was one of the very first involved in the industry, and he went through some trying years at the beginning. In those years I was involved with a funding agency, and there was a lot of skepticism. I was probably one of the true skeptics because people were asking us for money and we wanted to see the payback. I didn't believe guys like Irwin when they said production would double, triple, and so on and so forth. I eventually became convinced, and there has since been a tremendous amount of growth.

The true commercial endeavors started in the early 1980's. We are now seeing commercial operations in Newfoundland, Nova Scotia, and also in Quebec, as well as the original endeavors being expanded in both P.E.I. and New Brunswick. Right now, we are looking at production in 1986-1987 of about 6.5 million pounds, of which P.E.I. and Nova Scotia are each going to account for something in the order of 2.5 - 3 million pounds; and we see approximately another 300,000 pounds in both Quebec and Newfoundland; and,

possibly, even 100,000 pounds in New Brunswick this year, resulting in a total of 6.5 million pounds. Only five years ago, there was virtually nothing. We were strictly in an experimental stage. This is an exceptionally dramatic increase in production, an absolutely infant industry expanding by leaps and bounds. Production in Atlantic Canada next year is anticipated to double.

There are about 20 commercial growers in all of the five eastern provinces, but there are approximately 100 growers experimenting with pilot projects, and many will operate commercially as they master the technical aspects of the industry. Again, we are anticipating phenomenal growth and the markets appear to be there, if developed properly. Currently, we have more than 100 applications pending for leases; we have a growing number of participants, growing interest, and we have technology that has developed very rapidly over the past few years.

Industries that have developed as rapidly as aquaculture and specifically mussels, governments are usually leave governments to follow behind. We're quite exceptional at managing traditional fisheries, although some people may argue that point. But it has become very clear that aquaculture has developed so quickly over the past decade and especially over the past five years, that federal and provincial governments have not really sorted out their jurisdictions and their mandates. That confuses mussel growers and aquaculturists. Where do they go? Who is handling leasing? Who is handling development? Who has got a certain kind of program? It's incumbent upon governments to get that sorted out and I'm sure that many of you were heartened to hear at the last First Ministers' Conference, where the Prime Minister and premiers met last November, that one of the four or five priorities in the fisheries' area was aquaculture. It was agreed and confirmed that the federal and provincial governments should develop the framework that can support your industry.

So, on the Atlantic coast, the federal and provincial governments have now started to discuss agreements that will sort out mandates and jurisdictions, trying to come up with an idea for one-stop shopping so that someone can easily obtain all his information on licensing, development, and technical information. This would do away with a lot of the confusion that exists now.

THE CULTURED MUSSEL IN ATLANTIC CANADA - A PRECIS

by

Irwin Judson

Aquaculture Program Manager

P.E.I. Department of Fisheries

Introduction

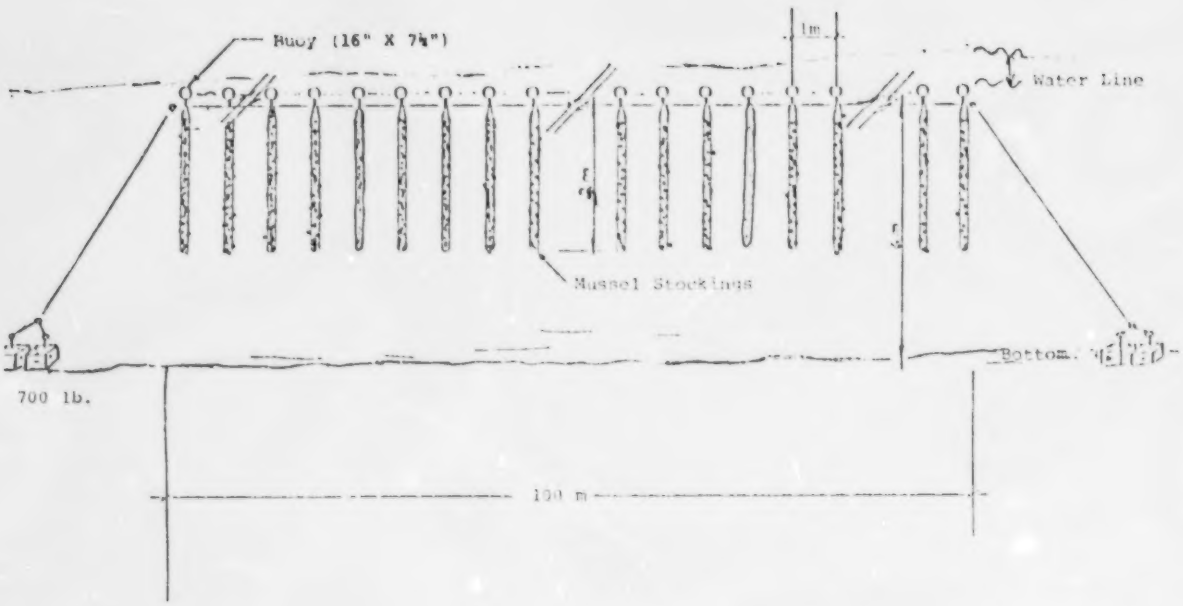
The cultured mussel industry in the Atlantic region began, almost simultaneously in several provinces, during the early to mid-1970's. This beginning was through government research and development projects which recognized the poor quality of our wild native stocks and the success of culture practices in Europe, especially Spain, Holland and France. These projects demonstrated the biological and technical feasibility of mussel culture. In 1978, the first major private effort to show its commercial feasibility was P.E.I. Mussel King. The proprietor of that early venture, Joe VandemBremt, is widely regarded as the pioneer of commercial mussel culture in this region.

This precis will try to portray the growth of the industry since that time, present the status of the industry early in 1987, note similarities and differences in the various provinces, and list a number of concerns common to the various areas.

Culture System

The longline system of suspended culture (Figure 1) is the universal system throughout the region, although some attempts at bottom culture have been reported in Nova Scotia.

Figure 1



There are minor differences, mostly to do with the length of the backline, the choice of Italian, American or Canadian materials used for the socks (also referred to as the "sleeve" in some places), the preferred type of seed -- either collected on artificial materials or gathered from natural mussel beds -- and, recently, the garland method of suspension in which long socks are draped on the line for increased speed of seeding the lines or for use in shallow water.

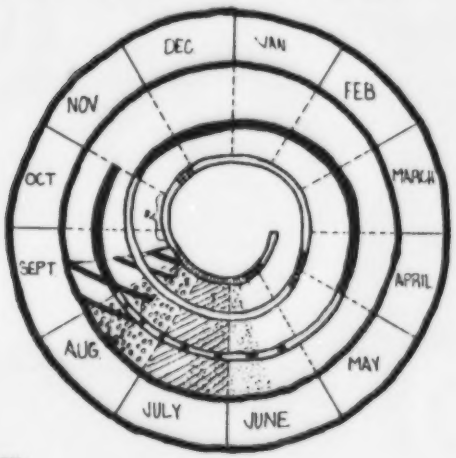
A new phenomenon is the trend toward specialization in the industry. There are a number of growers specializing in collecting seed for sale to other growers for ongrowing.

The activities carried out by the operator in bringing a crop through from seed collection to harvest are also remarkably similar throughout the region. The Life History and Mussel Farm Activity Chart (Figure 2) for Prince Edward Island shows a generalized concept of the procedures.

Figure 2

Life History and Mussel Farm Activity Chart

Prince Edward Island Cultured Mussels



KEY:

Spawning

Setting (Spat Collection)

Recovery Period

Secondary Spawning

Set out Collectors (3rd week May - mid June)

Set out Longlines (mid May - mid Sept.)

Seed out Socks (mid-late Sept. - end of Oct.)

Sink Lines for Winter (mid Nov. - end of Nov.)

Raise Lines for Summer (3rd week April - mid May)

Harvesting (Commences Nov. of Year 2)

Reduced Harvesting due to the poor condition of mussels during Spawning

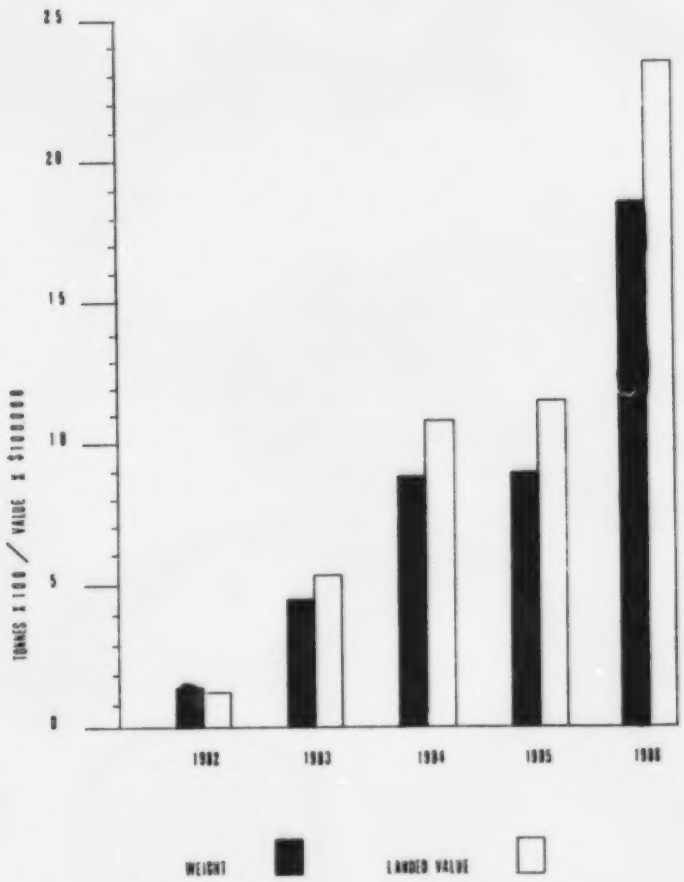
Production Levels

The total production in weight and value for the Atlantic Region, (New Brunswick, Newfoundland, Nova Scotia, Prince Edward Island, Quebec) for the period 1982-86 is shown as Figure 3.

FIGURE 3

CULTURED MUSSEL PRODUCTION

ATLANTIC REGION 1982 - 1986

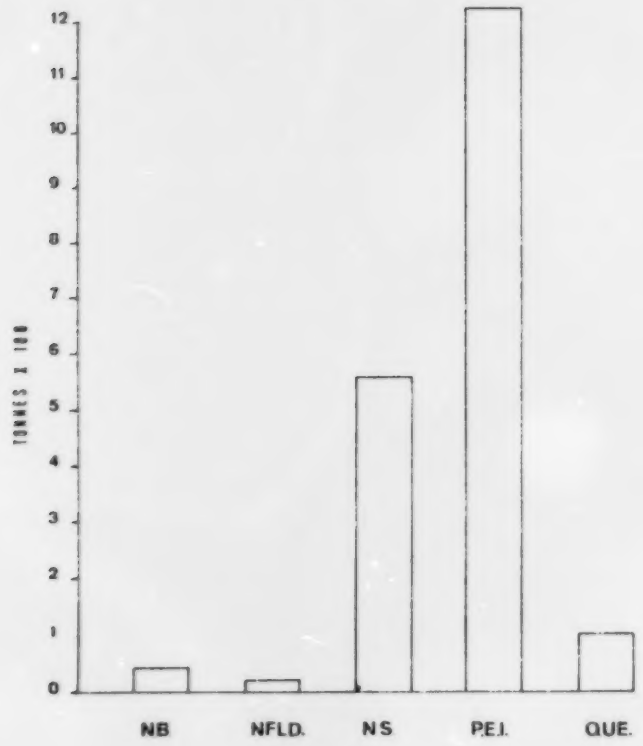


The production by weight for each province for 1986 is shown in Figure 4.

FIGURE 4

CULTURED MUSSEL PRODUCTION

ATLANTIC REGION 1986

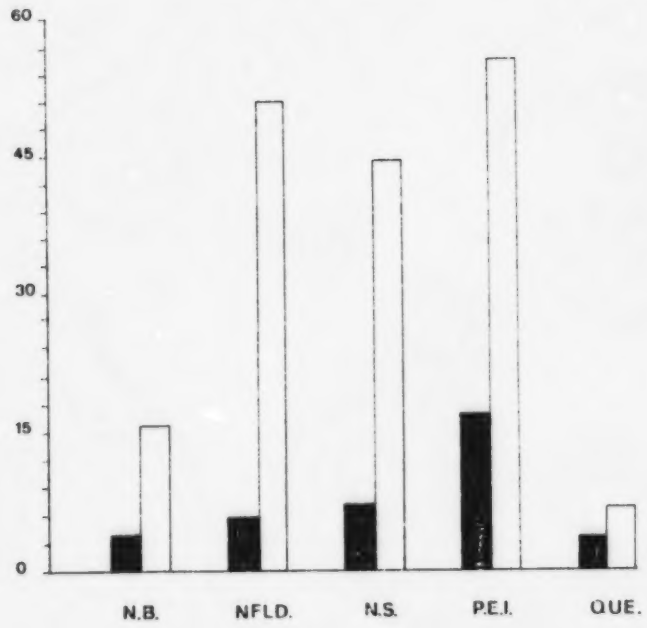


There are two general types of operation: the one producing significant commercial quantities of mussels; and the one growing smaller quantities, for example, less than 10 tonnes annually. The latter group includes growers going through the development phase, growers who include a mussel operation among other enterprises, first-year growers, and hobbyists. Figure 5 shows the breakdown by province of commercial and developmental operations.

FIGURE 5

CULTURED MUSSEL OPERATIONS

1986 COMMERCIAL ■ DEVELOPMENTAL □

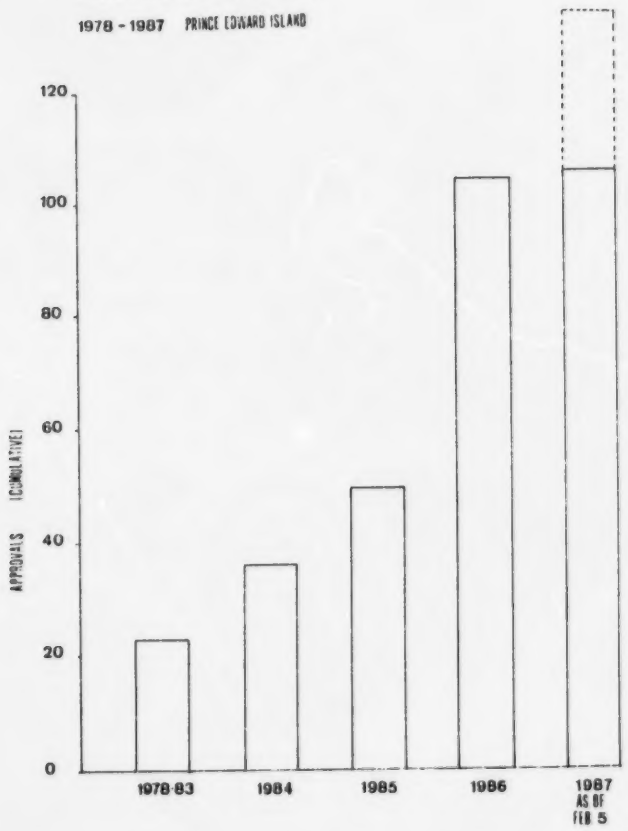


A backlog of applications for leases and permits is common, and moratoriums exist in some jurisdictions. Figure 6 shows the number of leases and permits approved in Prince Edward Island from 1978 to Feb. 5, 1987 and indicates a trend toward using all waters suitable for mussel growing. Other jurisdictions, especially Nova Scotia, (with a backlog of 140 applications) and Newfoundland, are exhibiting similar growth in the demand for leased bottom.

FIGURE 6

MUSSEL LEASES AND CONDITIONAL PERMITS

1978 - 1987 PRINCE EDWARD ISLAND

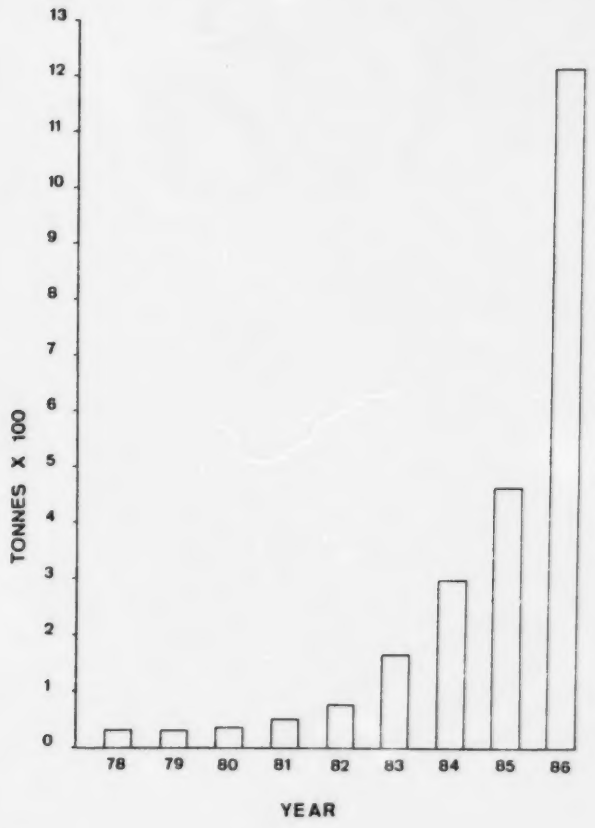


The Prince Edward Island annual production of cultured mussel from 1978 to 1986 is shown in Figure 7.

FIGURE 7

PRINCE EDWARD ISLAND

CULTURED MUSSEL PRODUCTION 1978 - 1986



Markets

Nearly all cultured mussels are sold fresh in the shell. Most production is sold locally in New Brunswick and Newfoundland. Quebec producers sell mostly in Quebec and Montreal. Prince Edward Island production is sold across the continent in both Canada (80 per cent) and the United States (20 per cent). Montreal, Toronto, Calgary and Los Angeles account for the bulk, while other cities such as Quebec City, Winnipeg, Vancouver, San Francisco and Miami are significant buyers. No information is available from Nova Scotia, although its total is believed to be an equal mixture of local and Canadian sales. European buyers have tried to buy in Canada, but supplies do not seem to be large enough yet.

Promotional activities have benefited major producing areas. These activities have included trade shows, sales missions, gourmet events, books, pamphlets and posters. Logos and trade names are prominent.

The quality of the product is consistently high throughout the region, except during the summer spawning season. Demand in existing markets continues to outstrip supply.

Prices to the grower range from 40 to 80 cents per pound in Quebec and Prince Edward Island. Retail prices are generally in the range of $0.99 to $1.49 per pound.

Public education is still required, especially in recognizing the difference between wild and cultured mussels.

There are both experimental and serious efforts underway for secondary processing in Newfoundland, Nova Scotia and Prince Edward Island. Proposed product forms include bulk raw shucked mussel meats, bottled marinated mussel meats, Kosher smoked mussels, breaded mussels, canned whole in-shell mussels, and a sauce-covered halfshell frozen shrink pack.

Concerns

Each region in the Atlantic area has specific concerns for the future. A number of those concerns is listed in roughly diminishing order.

a) **Summer mortality.** All regions except Newfoundland reported a late summer mortality of the larger mussels in 1986. Preliminary studies have not indicated disease or parasites to be the cause, although stress symptoms seem to be present. The industry wants answers to such questions as: What is it? Will it happen again? What steps should the industry consider?

b) **Carrying Capacity.** As the producers double and redouble production on their leases, and new leases are added in the estuary, the question arises as to the limit of that estuary to support mussel culture. When is the carrying capacity reached, after which continued stocking will result in diminished growth and reduced production? When these limits are recognized, how will the industry be controlled?

c) **Monitoring.** Little consistent monitoring of the industry has been done. There is a strong need for a broad range of monitoring activities to establish a frame of reference for unusual occurrences such as summer kill. Some of the suggested parameters are meat condition index, spatfall, growth rates, paralytic shellfish toxins, yields per culture unit (sock, longline, hectare), the environmental factors which affect growth, the impact of mussel culture on the ecology of the estuary, disease and parasite profiles, and bacteriological quality of growing waters.

d) **Extension Service.** Newfoundland, Nova Scotia and Prince Edward Island all report a level of demand that is producing a tremendous overload on extension services: Backlogs in applications for leases, permits, and incentive programs; repetition of mistakes (usually by people who choose not to follow established methods); lack of organized development strategies; excited but inexperienced people jumping into an industry where cautious

optimism is more justified; inability to satisfactorily respond to other listed concerns; and a shortage of good, readily-available information for site selection.

e) **Economic studies.** Economic studies are needed to define break-even point and cash flow characteristics for bankers, investors, and insurance agencies. Current tax exemption practices are ad hoc, time consuming and disruptive and should be restructured along lines similar to agriculture and fishing exemptions.

f) **Co-operation.** As the industry prospers, it is in danger of forgetting its roots, not recognizing past help, and failing to co-operate with industries and agencies which set it on its present firm foundation. The industry may yet meet with dangers and difficult problems which will need a continued spirit of co-operation. As an example, this workshop, an honest effort in technology transfer, has been called, counter-productively, by one industry leader, "a three-day coffee party".

g) **Marketing Systems.** Only P.E.I. reports satisfaction with the present system of marketing. Other provinces report unnecessary price competition and difficulty in co-operating with other small growers for joint sales and transportation.

h) **Wild Mussels.** Instances of misrepresentation of wild mussels as cultured, and of mixing the two, have been reported. Other shady instances of putting wild mussels through short term "culture procedures" and labelling them as "cultured" have been reported. Classification standards should be developed, advertised and enforced.

i) **Shortage of Seed.** Some growers experienced a shortage of seed in 1986. Improved reliability of spat is necessary and would include such measures as spatfall prediction and starfish control.

j) **Shortage of Sites.** Depth is a limiting factor in site selection, especially in the Northumberland Strait sections of New Brunswick, Nova Scotia and Prince Edward Island. An evaluation of technology for production in shallow waters is required.

k) **Storage of Inventory.** Interruptions in supply occur, especially in summer when the meat yield condition index is low and the mussels become more perishable. Methods are needed which would maintain the mussels in prime condition. One concept might be to store the summer's requirements offshore in deep cold water. Similarly, bad weather can interrupt winter supply. An onshore tank storage system would alleviate the problem as well as reduce personal risk in ice harvesting.

l) **Conflict.** As the cultured mussel industry becomes increasingly recognized as a legitimate viable business, conflicts seem to diminish. Conflicts still remain with oyster producers, pleasure boaters and cottage owners. The severity of conflict depends on: the affluence of the local area and the need for job creation.

Conclusion

The cultured mussel industry in Atlantic Canada is clearly in a growth phase. Buoyant markets have allowed it to survive early mistakes. New problems will be encountered, but emerging attention to monitoring and applied research programs will strengthen the industry's ability to survive.

The ultimate size of the industry is difficult to predict. Optimism is the most appropriate outlook for an industry whose production is doubling and redoubling, whose growth in demand continues to outstrip that of production, and whose prices continue to rise.

THE CULTURE BIOLOGY OF MUSSELS

by

Bruno Myrand

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Gouvernement du Quebec

THE SUPPLY OF YOUNG MUSSELS

One of the first things that comes to mind when we speak of spawning is the supply of young mussels. It is one of the main concerns of the mussel grower, who must ensure a supply of seed mussels each year in order to continue his operation. This young mussel supply process is directly related to the biology of reproduction and to the culturing of blue mussels.

In Atlantic Canada, the spawning period varies from one location to the other, and from one year to the next. Generally, the spawning period occurs from early May to late June. Figure 1 shows the major steps prior to the attachment of spat to collectors.

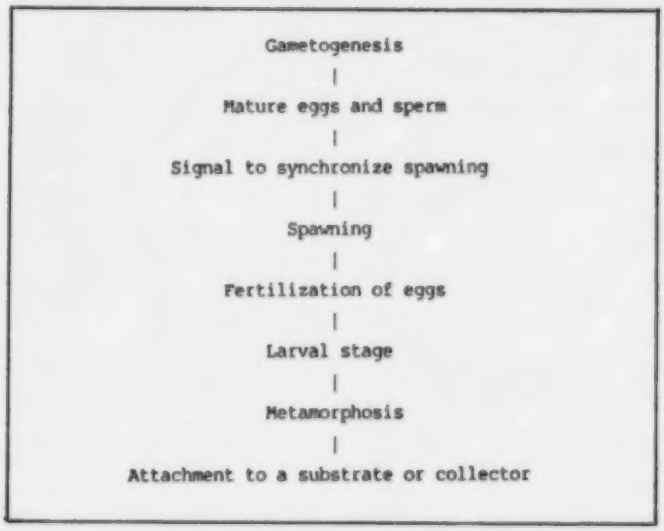

Figure 1. Major steps before attachment of the spat to the collectors

Once the mussels are ready to spawn, they await a signal from the environment to synchronize their spawning. This signal must be clear enough to enable a large portion of the population to recognize it and react. The signal may be physical (collision or tossing), thermal (a rapid increase or decrease in temperature) or chemical (a variation in salinity). Spawning can even be triggered by the sudden appearance of abundant food.

To reproduce, male and female mussels discharge eggs and sperm into the surrounding water, where chance encounters permit fertilization. It is easy to see why synchronization is so important for successful reproduction. Imagine what would happen if mussels spawned whenever they felt like it. The chances of the eggs and sperm getting together would be minimal. However, the synchronization of spawning by many individuals ensures the presence in a body of water of a large quantity of eggs and sperm at the same time.

After fertilization, the young mussels enter the larval stage (Figure 2). During this period, the larvae float more or less passively, carried along by the currents. They stay near the surface, where growth and development opportunities are better because of the warmer temperature and more abundant food. This period is also characterized by major physical transformations in the larvae. Once the larvae reach an advanced stage of development (veliger stage), they are ready to attach themselves to any substrate collector with which they come into contact which meets their requirements. What they require is simply a firm substrate covered with marine deposits (algae, hydrozoa, etc.).

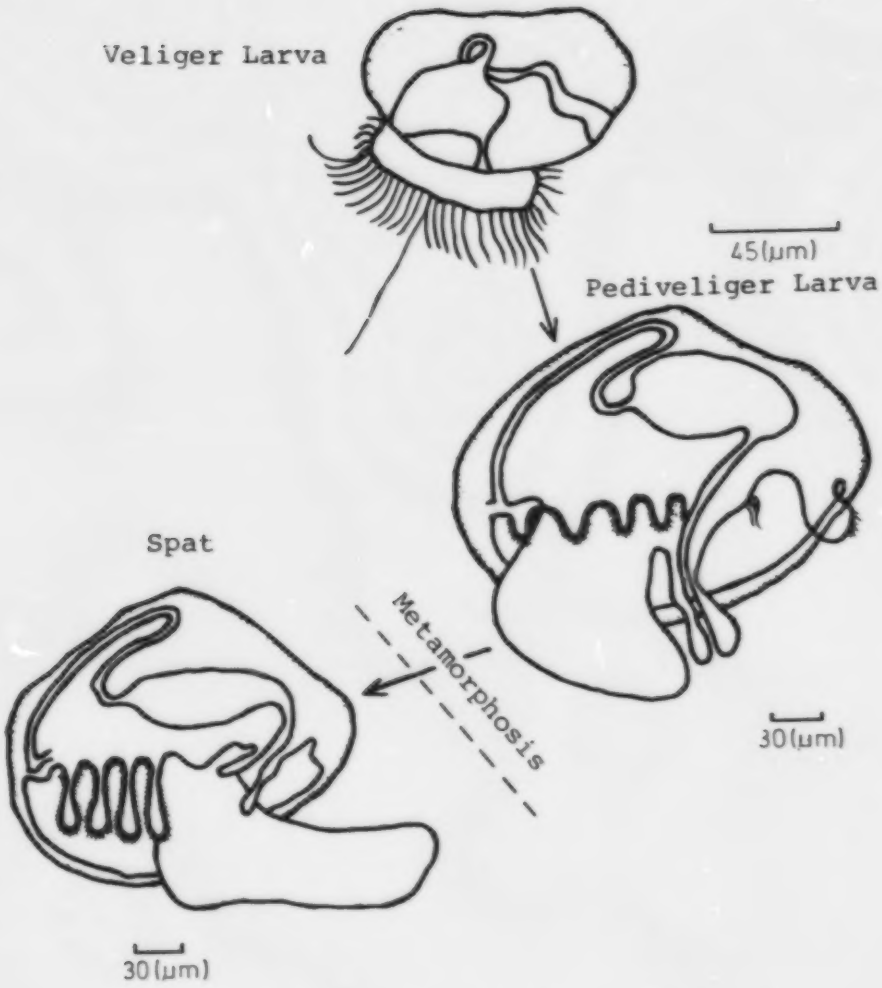

FIGURE 2: SIMPLIFIED MORPHOLOGY OF THE MAJOR STAGES IN THE LARVAL DEVELOPMENT OF THE MYTILUS EDULIS.

TAKEN FROM DARE, P.J. 1980. MUSSEL CULTIVATION IN ENGLAND AND WALES. LAB. LEAFL. MAFF DIRECT. FISH. RES., LOWESTOFT #50

When the larvae reaches this pediveliger stage, their behaviour changes to increase their chances of coming into contact with a substrate. The larva being carried by the currents drifts along with its foot extended to attach itself to any substrate encountered. When it does encounter something, the larva literally explores the substrate to determine whether it meets the requirements. If it does not, the larva detaches itself and drifts off again until it comes into contact with another substrate on which it begins the same process, or until death puts an end to its wandering. Larvae can spend several weeks searching for an appropriate substrate. If they are not successful after a few weeks of searching, they die. If a satisfactory substrate is found, the larva begins to metamorphosize, thus concluding its larval stage. Once this metamorphosis is completed, the individual is no longer a larva, but has become a young mussel, called a spat.

The larval stage is very important because during this time the larvae are very vulnerable. They are subject to considerable predation by a large number of organisms. More fragile than the adults, they are in danger of encountering difficult environmental conditions while drifting. It is, therefore, not surprising that, according to estimates by specialists, at least 99 per cent of larvae die before they can attach themselves. The longer the larval stage, the higher the losses. The length of this larval stage depends on environmental conditions, including temperature, available food and accessible substrates. The more favourable the conditions for larval development (high temperature, abundant food), the shorter the larval period with its related risks. Added to this is the risk that the longer the larval period, the greater the risk that the larvae will be carried away from suitable substrates by the current.

The settling of spat on the substrate is complex and affected by a number of factors over which the mussel grower has no control. In nature, it is impossible to have any control over the synchronization of spawning, the success of egg fertilization, or the length of the larval stage. The mussel grower only intervenes where it is possible for him to do so, when the spat is attached. Here he gives nature a hand by providing larvae with artificial substrates called collectors (often used socks). Larvae searching for substrates come into contact with collectors and attach themselves in large numbers. This recruitment on collectors allows large numbers of larvae to survive that would otherwise die for lack of a suitable substrate.

The number and complexity of the stages before the mussel attaches itself to the collectors is an indication of the variety of elements that can affect success. Thus, it would be very difficult to clearly identify the causes of a low harvest; too many elements are involved.

One last factor to be dealt with before we set aside the biology of the mussel is that larvae floating in the water may drift far from their starting point during this period. In this regard, an English biologist has collected young mussels 150 km from their starting point. This leads us to the following observation: spat attached to collectors do not necessarily come from the area near the collector, but are often from some distance away. Consequently, spat found in the harvest area comes from a population living in an area that may be difficult or even impossible to identify. The mussel grower, therefore, has no control over the population supplying him with spat. It is practically impossible for him to do anything to protect "his" spawners. If this population were to disappear for any reason, he would bear the consequences.

GROWTH

Assured of an abundant supply of young mussels, the grower must then help them reach marketable size (50 mm) as rapidly as possible. In fact, rapid growth has many advantages. First, it enables a shorter production cycle, resulting in reduced costs. In addition, it reduces the risks associated with their loss. The longer mussels stay in the water, the more they are exposed to losses caused by winds, predation, broken collector lines, etc.. Rapidly grown mussels provide a better quality product: cleaner and thinner shelled, more abundant meat, higher meat yield and an absence of pearls. This absence is explained by the fact that pearl formation takes from two to four years.

Growth constitutes the response of all the mussel's internal functions: physiological, cellular and biochemical. With a little imagination, one can say that growth is the mussel's net answer to its environment. If the mussel is placed in a suitable environment, it will growth rapidly. But if surrounding conditions are not favourable, growth will be slow.

Having established the importance of rapid growth in mussel breeding, we should now examine the main factors that affect it.

The first is temperature. Since the mussel is a cold-blooded animal, temperature has a considerable influence on its biological performance, including growth. In the laboratory, it has been determined that, with an equivalent amount of food, growth increases at a logarithmic rate when the temperature rises to between 3 and 20°C. However, growth decreases markedly when the temperature climbs higher than 20°C. Several of the mussel's internal functions may be disturbed when temperature exceeds this threshold.

Obviously, everything that concerns food greatly influences growth. In this regard, the quality of the food is an important factor. The blue mussel is a filter feeder that uses all particles in the water that are retained by its branchiae. The branchiae retain all particles larger than

0.001 mm. Therefore, mussels feed on particles of a size between 0.001 and 0.1 mm. These particles form an amalgam of varied composition and quality: microscopic algae called phytoplankton, bacteria, detrital material, and silt. Of these particles, phytoplankton is considered to be superior to the others. Since phytoplankton is found in great abundance in the upper water layers, this area provides the best growth conditions. Irish researchers compared the growth of mussels placed on the bottom with others at the same site, but suspended in the water column. It took six years for the mussels on the bottom to reach a size of 50 mm, while those suspended in the water took only a year and a half. The researchers attributed this marked difference to the fact that the off-bottom mussels had access to better quality food (mainly phytoplankton); mussels on the bottom fed on more varied food of lesser quality.

The most important factor in growth is, undoubtedly, the available food. It is even more important than temperature, according to some observers. For example, fall growth is very good despite a considerable decline in temperature. Also, spring growth is very rapid despite low temperatures. These are the periods of the year when food is most abundant. In addition, a Swedish researcher has observed that mussels suspended near salmon breeding pens showed winter growth as rapid as during the summer, even in temperatures near 0°C. He attributed this to the abundance of food particles (not consumed by fish) that the mussels picked up. So the main factor controlling growth is the available food, not the temperature. The examples given here indicate that, generally, growth is more rapid when food is abundant, regardless of temperature.

When it comes to available food, two different but closely related elements are involved. Available food refers to both the concentration of food present in the water at a given moment and the currents. The concentration of food can easily be described as all the food present in a litre of water. However, as the mussel is a sedentary organism, it cannot search for its food. The food must come to the mussel. Currents are important, therefore, because they bring food to the mussel. When the

renewal of food by currents is insufficient, mussels quickly exhaust the supply and are soon underfed.

The quantity of available food will determine the maximum productivity of the environment, and that will place a limit on the extent of mussel spawning in a given location. Obviously, no one site can provide satisfactory growth for all mussels present, regardless of the quantity. Determining the production limit of an environment involves a study of its support capacity.

Having access to abundant food of good quality is one thing, but being able to eat it is another. Thus, any factor that affects the ingestion of food by the mussel will have repercussions on its growth. This is the case, for example, with density. The more mussels at a given location, the less food there will be for each one. Physical constraints that hinder the expansion of shells and that limit food rations reduce growth. This is also true for any sudden change in environmental conditions, since the mussel protects itself from danger by halting its activities and closing its shell. This reaction lasts until conditions are re-established or the mussel has adapted to the new conditions. When its shell is closed, the mussel does not feed and, therefore, cannot acquire the energy used for growth. Any factor that may cause stress to the mussel, therefore, will also have repercussions on its growth.

The length of time the mussel is immersed in water during tides is also an important factor in its growth. Out of the water, the mussel has no choice but to stop its activities and close its shell. The length of time the mussel may feed depends on the mussel's position in the tidal zone. It seems growth is negligible when the mussel is out of the water for more than 50 per cent of the tidal cycle.

One last factor that may affect growth is the salinity of the water. Laboratory studies have shown that growth is good when salinity is somewhere between 18 and 31 $^{o}/_{oo}$, and is optimal around 26 $^{o}/_{oo}$. Any rapid change in salinity (eg. arrival of fresh water) may slow of growth, following the closing of the mussel's shell. Growth would become negligible following a 50 per cent reduction in the normal level of surrounding salinity.

Now that the main factors controlling growth have been discussed, we can draw certain conclusions. First of all, it is clear that off-bottom cultivation is best. It allows mussels access to more abundant and improved quality food. In addition, the mussels are constantly immersed and can, therefore, feed without interruption. The generally more stable environmental conditions in the middle layer of water (especially during the tidal cycle) limit the stress put on them. Consequently, they only rarely have to stop their activities, unlike mussels in the tidal zone. Placing mussels in net bags, as is done in Atlantic Canada, provides control over the density of mussels under cultivation. Also, the water is usually warmer near the surface than at the bottom at a location distant from the shore.

When it is possible to choose between different sites, certain criteria must be examined in light of the knowledge we now have. Great weight must be given to the availability of food. A site where food is more available will ensure better growth and a higher production potential. The site should also have a relatively stable environment, which implies that a site subject to rapid changes in salinity created by the arrival of massive amounts of fresh water would not be suitable. Lastly, the water temperature of the site should not greatly exceed 20°C. Above all, one must avoid a site where the temperature reaches almost 25°C; the lethal temperature for blue mussels is around 27°C.

MEAT YIELD

After obtaining an abundant supply of seed mussels, and ensuring their rapid growth to market size, the mussel grower must consider the quality of the product. Among the numerous quality criteria to be considered, one of the most important is undoubtedly meat yield.

Meat yield is calculated as follows:

$$MY = \frac{\text{Weight of cooked meat}}{(\text{Weight of cooked meat} + \text{Weight of shell})} \times 100$$

This method of calculating the meat yield illustrates the importance of any factor that leads to a weight gain or loss. This quality index can also serve as an eco-physiological index characterizing the general condition of the mussel.

Meat yield is the result of several antagonistic factors. For example, an increase in weight results mainly from: (1) the accumulation of reserves when available food conditions allow, as well as (2) the production and accumulation of eggs and sperm in preparation for spawning. A loss of weight comes mainly from: (1) spawning (expulsion of great quantities of eggs and sperm) and (2) the utilization of reserves accumulated in the tissues. It is, therefore, not surprising to find that meat yield varies considerably throughout the year. The annual meat yield cycle generally follows this pattern: (1) maximum yield just before spawning when the mussel has accumulated a considerable quantity of eggs and sperm in its tissues, (2) rapid decline at the time of discharge of eggs and sperm, (3) lowest level at the end of the spawning period when a large portion of its reserves have been used. The yield increases again in the fall in response to an increase in food and then stabilizes during the winter.

It is obvious that spawning is a major factor in meat yield. Spawning results in meat yield falling from its highest level to its lowest. After spawning, available food has an important effect on meat yield, as its abundance determines if the mussel can accumulate reserves or must use up those it already has.

LEASING POLICY/RIVER DESIGNATION SYSTEM *

by
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LEASING POLICY

Leasing is a very important aspect of shellfish culture, both for oysters and mussels. As well, we should be looking at leasing in salmonid culture as the lease implies a property right.

I think the first question we should ask ourselves is: Why do we need a lease? Why don't we go out and harvest oysters from the bottom of bays or estuaries in the same way we go out and fish herring, smelts, eels and other species? First, you're putting your labor and your money into the venture and you want to be assured of ownership. The lease establishes ownership of the product you produce.

Secondly, you need a lease because, when you go to lending organizations, they will want to know that you own what you produce and that everybody will not have the right to fish it. With a lease, you have the sole ownership of all the mollusc shellfish on it.

Thirdly, and probably most important for people who have a great deal of oyster or other shellfish products on their lease, is the need to be able to establish ownership in court. If any theft or damage occurs to your stock, you want to be able to bring judicial proceedings against the individual responsible and to reclaim your losses.

* This presentation was repeated for oyster growers during their sessions.

A second interesting question when considering leases is, "Who has the jurisdiction to issue them?" As most of you know, if you're involved in the commercial fishery for lobster, herring or other species, the federal government has sole jurisdiction over the fishery. This is guaranteed by Section 91.12 of the British North America Act, and this section is clear and explicit. But, it is also quite clear that the federal government cannot transfer ownership of any single species to an individual. For example, it can't say that I own all of the herring in Charlottetown harbour. It does have the authority to license, regulate, and prosecute, but does not have the authority to transfer ownership.

Who has that authority? Under Section 92 of the British North America Act, the provinces govern their own resources. They have authority over property rights and, indeed, have a vested interest in the water column bottom because they claim it to a three-mile limit. So what kind of a dilemma does that leave us? We have the federal government regulating the fishery. We have the provinces with certain rights in the fishery -- to regulate property rights and the ownership of the bottom of the water column.

Our predecessors were very astute in their approaches to the problem. They had both levels of government meet and sign agreements. In P.E.I., an agreement was signed in 1928, in Nova Scotia in 1936, and in New Brunswick, the process extended over the period from 1912 to 1960. These lease agreements transferred authority from the provinces to the federal government so that it had the right to issue leases. This was very important because the federal government already had authority over the fishery, and now it also had a mechanism to transfer property rights or ownership to individuals with regard to leases.

Even if we now transfer authority back to the provinces, as was the case prior to those agreements from the time of Confederation, what we would have is the federal government regulating the fishery and the provincial governments leasing ownership of the bottom to individuals. Without some

mechanism in place, it would be difficult for both levels of government to smoothly regulate the fishery, to enhance it and to try to help the industry to grow.

We've recently experienced certain changes in leasing patterns. In Nova Scotia, the provincial government has indicated a willingness to assume control over leasing. This was in response to Prime Minister Mulroney, who, during a previous period, had indicated he would be willing to allow the provinces to assume jurisdiction over leasing and other aspects of the shellfish industry. So, in Nova Scotia, they took the Prime Minister up on his word; they accepted. The transfer of the leasing jurisdiction from the federal government to the provincial government of that province is now in progress.

This development brings up a question. If we do transfer the leases from one government agency to another, what type of process does one have to go through? In Nova Scotia, the provincial government is following this path: First, grower must apply to the provincial government. Secondly, a site evaluation takes place to ensure that it is suitable, is not interfering with other activities or other fisheries, and that it will, probably, be viable. Thirdly, a bacteria and heavy metals analysis is conducted. Assuming that these analyses are clear, the application is reviewed through six provincial agencies and through four federal agencies. After that, there is a public hearing regarding the lease. If everything goes well to this point, temporary approval is given to the entrepreneur to secure a lease. The entrepreneur then has to secure the services of a provincial land surveyor who surveys the lease to obtain the required description of the property so it can be put into a legal contract. Assuming that is done, the lease contract is then signed for a 10-year period.

In the Bay of Fundy area, in New Brunswick, I understand they are involved in a changeover procedure now, switching authority from the federal government to the provincial governmen , mainly for salmonids. On the Gulf side of the province, and in the provi.ce of Prince Edward Island, leasing is still under federal control.

How do you apply for a lease under federal jurisdiction? We have a policy in place and, basically, the procedure is as follows: First of all, you apply. There's a site evaluation. If it's for bottom culture, as in oyster culture, approval is given. You then get a provincial land surveyor to complete a survey, and we enter into a 20-year contract with a 10-year renewal clause. But, if surface culture is involved, there is one further step. You have to get NWPA approval. Under the Navigable Waters Protection Act, Transport Canada must ensure that navigation is not obstructed in any navigable waters. So you have to apply for NWPA approval or an NWPA exemption under Section 1 of the Navigable Waters Protection Act. That can take some time. If it's an approval procedure, it takes a minimum of six weeks and, more likely, three to six months because the application has to go to Ottawa. If it's an exemption under the policy, it can be done in a relatively short period of time by the local office.

So we have two different systems working in the Atlantic provinces, one being enacted by the province of Nova Scotia and an older system, which is a federal system, in P.E.I. and the Gulf side of New Brunswick. I'm not sure what procedure is used in Quebec at the moment.

Why try to secure a lease, why try to secure NWPA approval? I think the bottom line here is to encourage oyster culture, whether we're using a leasing or public fisheries system, so that we can increase production, with the ultimate aim of higher returns to the fishermen.

RIVER DESIGNATION SYSTEM

We have some other problems in leasing, and they include other water users. There are mussel growers, salmonid farmers, as well as many other people who use the waterways. There are people who use them for recreation -- boating, swimming, and other types of activities. There are also people who have businesses along the shore, including marinas for example, and they use the surface of the water column. There are also other groups, such as nature trusts and heritage people. There are wildlife people who operate sanctuaries. A variety of people make demands on the water system. So, in order to address all of their concerns, we have proposed, on P.E.I., a River Designation System.

The River Designation System is, basically, a plan which provides for the common use of the water, taking into consideration the oyster culturists' needs, the mussel growers' needs, the salmonid growers' needs, and the public's needs for recreation, tourism and business.

The system is nothing more than an outline of how we might use the river systems in the various bays and estuaries around P.E.I. The same considerations can be applied equally to New Brunswick, Nova Scotia or any other river complex.

The following is a very basic example of how the River Designation System works. First of all, it's a very simplified system, using three letters. "A" means an area is subject to automatic approval. In other words, if an oyster culturist comes in and he wants to know if he can get a lease in a particular area, he will be told "yes" immediately, because this area has already been approved for oyster culture and he is free to apply in that area. If the area he is applying for is designated "B", there are other types of considerations for this area, and an application will have to go through a review process prior to approval. If he is applying for an

area designated "C", he is automatically denied. This may not be the news he would like to hear, but at least when he walks into the office and talks to the people in the leasing division, he will get an answer. He'll know that there is no chance to obtain a lease in that particular area.

We use the letters A, B and C, and we use them in two-letter combinations. The first letter in the system designates bottom culture, that is, bottom culturing of oysters, mussels, quahogs, and other shellfish species. The second letter in the system designates surface culture, which is particularly relevant to people who are floating rafts, hanging fences, or using mussel lines. These people are using the water column on the surface. That's why we have the two designations, bottom and surface.

For example, a well-known river on P.E.I., the East River, is designated AC in a particular area, A referring to bottom culture, so there is automatic approval for a bottom culture lease, and C referring to automatic denial for any mussel culture in that area. This is an area of high productivity for oysters and the oyster industry has indicated to us that they do not want any mussel culture there because of the conflict between mussels and oysters. Another area might be designated CB. The C means automatic refusal for bottom culture, and it means a review for any surface culture. That designates a small area for mussel culture, which is removed from the oyster-producing areas in that river system.

There are areas in which we will not grant leases on P.E.I., and I'm sure that you would have the same concerns in other provinces, include contaminated areas. We will not issue leases in any public fishing areas. We maintain very strict control on that. We will not issue any leases in or near dump sites or dredge spoil. It contains a number of heavy metals, other contaminants, a lot of silt, and sand. When it is dumped, it has the effect of killing shellfish in the area nearby. So what we do is put a buffer zone around the dredge sites, and we will not issue leases there. We won't issue leases in federal government water lots, i.e. around harbors. We also will not issue leases in, what we call, private water lots. On

Prince Edward Island, prior to Confederation, there were areas in Charlottetown, Summerside, Georgetown and, I believe, in Souris, where the provincial government gave out water lots. In those days, the term "water lot" referred to an area going out from your piece of property, underwater, to the edge of the channel. We won't issue leases in particular areas reserved for culture. The Bideford Reserve is one such location. We don't issue leases in experimental areas, areas that we designate as experimental for a particular purpose.

This all means that we take several factors into consideration when issuing leases. One is the safety of navigation. Whether we like it or not, navigation takes precedence over the fishery, as established under the British North America Act. It is also established in common law and in English law that navigation takes priority over any other activity on the water. So we have to ensure that we have channels open to the public for safe navigation. Another impediment would be a busy wharf area. There may be a lot of traffic, and we want to avoid conflict between culturists and commercial fishermen in the Gulf.

Indeed, the system allows for other types of closures. The area in front of a park may be designated CC, BC or AC, depending on what the park is used for. Areas in front of marinas or other businesses may be designated for no culture activity so that people will have safe access to the water column.

The whole purpose behind this exercise is to take into concern all of the people who use water resources, so that we can avoid conflict in the future and so that we can assure you there will be areas still available for culturing oysters or culturing mussels.

Now we're under considerable pressure from the Heritage Foundation, the Wildlife Societies, the cottage lot owners, the sub-developers, the businessmen, the Department of Tourism and others to avoid putting culture in certain areas because, perhaps, people don't like the look of the buoys,

they don't like the look of boats on the water, or they don't like the look of rafts in front of their cottages. I'm sure a number of you are getting the same complaints. That is why, on Prince Edward Island, we have gone through this whole exercise. Perhaps now, we can avoid some of the problems.

One additional feature for which we haven't received approval yet, affects safe navigation corridors. We're seeking permission from Transport Canada to require that the mussel culturists, or anyone else with surface culture, use reflective buoys, buoys with reflective tape, similar to navigational buoys, so that when boaters go up river at night, they will be able to see the buoys clearly. We have not received approval from Transport Canada to do that, yet, but we are continuing discussions to see whether it is possible. We want to put in reflective buoys to mark the channels very well so people can get to their moorings at night or during inclement weather.

In addition, we have to consider a few other people, the people who own the shore because, under Canadian law, we have a section which refers to riparian rights. A riparian right is the right of a landowner to access the sea from any point on his land. Now let's say that I am a very difficult man and I go out in front of Joe VandemBremt's lease and erect something that is going to stop him from having access to his lease. He can then have an injunction laid against me, have me indicted and make me remove that particular structure from in front of his property. I have interfered with his riparian right of access. So we're putting in this type of system to avoid this problem.

We're also asking mussel growers to put through corridors in the middle of their leases so that people can get through to the channel to enjoy boating, skiing, swimming and other activities. Again, this is a feature to avoid problems in the future between the land owner, the water user and the aquaculturist.

SPAT PREDICTION

by

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Development of Mussel Larvae

Although mussel larvae are found in plankton throughout the summer, there are usually two peak periods for spawning in Prince Edward Island. Mussels spawn with rising temperatures in late spring-early summer, and a lesser spawning occurs in early autumn with falling water temperatures.

Spawning usually occurs en masse. The eggs are 68-70 microns in size. Fertilization occurs externally. Early development stages take place with a ciliated trocophore larvae appearing about 24 hours after fertilization. The first larval shell, seen in the Prodissoconch I or straight-hinged veliger larvae, appears at about 48 hours at a length of 95 microns and a height of 70 microns (note: times are temperature-dependent).

When larvae reach about 150 microns in size, a rounded umbo forms and the larvae are referred to as umbo stage larvae or Prodissoconch II larvae.

Statocysts, or eyespots, develop in mussel larvae at 225-245 microns.

The larval period lasts two to four weeks and is dependent on temperature, suitable food and settlement substrate.

Metamorphosis, or setting, usually occurs when the larvae reaches approximately 260-280 microns. The organism then forms the dissoconch or adult shell, as shown in Figure 1.

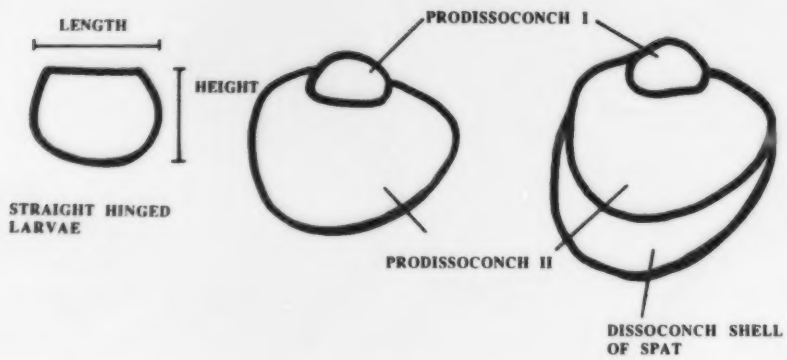

Figure 1. Veliger Larvae

Sampling Methods

Bivalve larvae are not usually dense enough to be sampled in a small quantity of water. Concentrating the larvae by sieving is necessary to obtain sufficient numbers to give enough information to indicate the larval population structure and density.

There are two methods commonly used to sample for bivalve larvae.

The simplest and probably the most reliable method uses a plankton net which is towed behind a slow-moving boat. It is very important that the net have the proper mesh opening. If one is sampling for the early stages of bivalve larvae, a net with a mesh opening of 64 microns is required, as early stage straight hinge larvae will pass through any larger mesh.

A very useful and relatively inexpensive net is one of 100 microns. One can be obtained as a student-model plankton net, and will sample well enough to capture all but the earliest stages of bivalve larvae.

To obtain a representative sample using a plankton net, one must allow the net to pass slowly up and down through the water column, while being towed for a specified period of time (e.g. five minutes). The vertical position of the net is controlled by boat speed. Sufficient care must be taken to keep the net from touching bottom. If the net does grab some sand or silt, the sample is useless because separation of the bivalve larvae from the sand is nearly impossible. Figure 2 depicts the plankton-net method of collecting bivalve larvae.

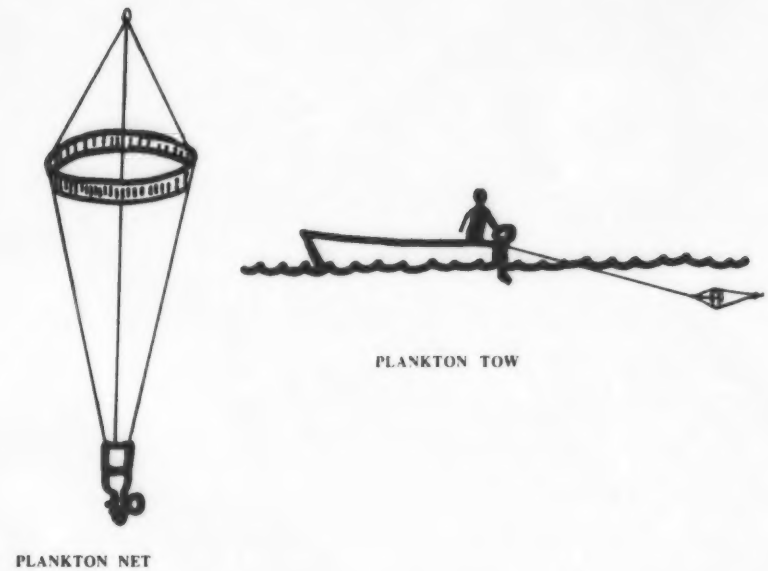

Figure 2. Plankton-net method of bivalve larvae collection.

The other method in common use for sampling bivalve larvae uses a submersible bilge pump powered by a 12-volt battery. By incorporating a domestic water meter at the discharge end of the sampler, the quantity of water can be recorded and the number of larvae/litre can be calculated to determine their density. The discharge end of the pump sampler can be run into a plankton net or into a specially-made sieve using the same monofilament nylon mesh used to make plankton nets (preferably 64 microns). Figure 3 shows the set-up for the bilge pump method of bivalve larvae.

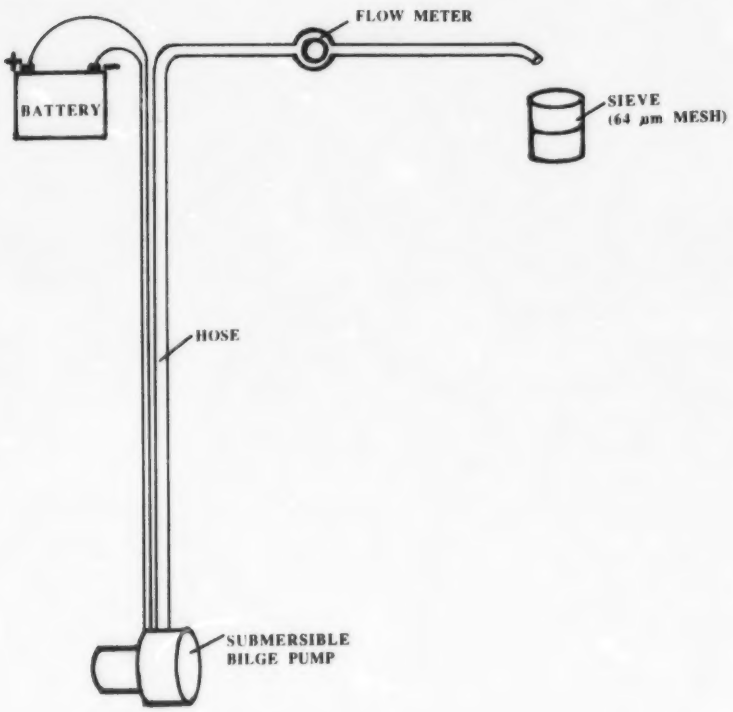

Figure 3. Bilge pump method of bivalve larvae collection.

Sample Preparation

Plankton samples are brought in from the field and the bivalve larvae are separated from it by swirling it in a 100 mm watch glass. The larvae will concentrate in the centre of the watch glass. The lighter organisms remain suspended and can be separated from the larvae by tilting the watch glass gently and pipetting the suspended organisms. Repeated washings with sea water will leave only the molluscan larvae.

This sample is then placed in a Sedgewick rafter cell and viewed under a microscope.

Identification

Identifying bivalve larvae is not easy. This is particularly true in the straight hinge stage. Because many bivalve species may be present in the plankton at one time, identification is difficult until the observer has obtained a good deal of experience.

Photographic studies showing development stages have been published and are particularly useful (Loosanoff V.L., H.C. Davis and P.E. Chanley, 1966; Sullivan, C.M., 1948).

Identification is based on:

1. Height to length ratio
2. Entire shape
3. Shape at anterior and posterior ends
4. Position of the umbo
5. Color
6. Length of Prodissoconch I
7. Teeth and ligament

Prediction

Prediction is based on routine samplings (every two or three days), identification of a brood, and on following its development through to metamorphosis.

Comparisons of the length measurements of larvae from the plankton with published photographic studies enable the trained observer to predict spatfall within a few days.

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SITE SELECTION: ASSESSING BIOLOGICAL POTENTIAL

by

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INTRODUCTION

The culture of the blue mussel is currently undergoing rapid development in the Maritimes. Many mussel farms are doubling their production level every year, both by expanding the area under culture and by increasing the number of mussels per unit area. If mussel culture continues to grow at this rate, one can foresee a time when the biological potential of a site may be exceeded. In this context, we define biological potential as the maximum number of market-sized mussels that can be grown in a given area within an acceptable time. This optimal stocking density, referred to as carrying capacity, is influenced by the physical and biological characteristics of the system. It is important to maintain stocking density below this optimal level in order to avoid problems associated with overstocking, such as slow growth and high mortality.

In this presentation, a rough method for estimating the biological potential of an area is presented. We stress that the accuracy of our estimates is dependent on the validity of our assumptions. We have, however, attempted to be conservative, whenever possible, so as to underestimate, rather than overestimate, the carrying capacity. Basically, three numbers are required: (1) the available food, (2) the food intake by the mussels, and (3) the water exchange. Most of the data we present were collected at a mussel farm located at Whitehead, near Canso, Nova Scotia. Although we had little data, we have also attempted to estimate the carrying capacity of Boughton River, P.E.I.

AVAILABLE FOOD

The word seston is often used to describe total suspended matter in the water column. This includes both organic particulates, such as phytoplankton, and inorganic particulates, such as sand grains. In this study, we determined both the weight of total particulate matter (TPM) and that of the organic faction or particulate organic matter (POM). The POM is composed of phytoplankton and organic particles which mussels can use in order to grow.

Figure 1 shows the levels of TPM and POM per litre of seawater (from May 7 to Dec. 1, 1986) in the basin at Whitehead. The levels of POM varied from 0.33 mg/l in October to 1.28 mg/l in May. Relative to the levels of TPM, the organic fraction varied from 33 to 55 per cent. We know that this site was ice-covered until April 15; hence, we assume that the peak food levels observed in early May likely represent the end of the phytoplankton bloom, which typically occurs soon after breakup. The influence of the local spring runoff is noticeable in the high levels of TPM recorded in early May.

Levels of POM and TPM vary among sites and seasons, depending on factors such as river discharge, land drainage, tidal re-suspension, periodic storms and shore erosion. In a survey of 12 Nova Scotian sites, food levels were generally greater than 0.5 mg/l and as high as 5 mg/l in areas with significant river input. Mussel farms in P.E.I. are typically located in estuarine systems where food levels would be greater than those indicated in Figure 1.

FOOD INTAKE

Food intake can be estimated by measuring the amount of food filtered per mussel per day from the water column. To determine the filtration rate of mussels at Whitehead, we set up a raft with a series of in situ grazing chambers. In contrast to most traditional grazing measurements where the

food particles are pumped into the chambers, the mussels were allowed to graze on the undisturbed natural particle spectrum.

Figure 2 indicates the weight of POM removed per day and the filtration rate of a 60 mm mussel. Although these trials were only preliminary, the estimates obtained are comparable to those in the literature. The values ranged from 20 mg/day in September to 44 mg/day in mid-August. Note that the greatest food intake was observed when water temperatures were at their maximum; however, we need further studies in order to verify this relationship.

We have used a ration of 25 mg/day in the calculation of the carrying capacity. This is consistent with other estimates in the literature and with our observations of substantial mussel growth at this level.

WATER EXCHANGE

Water exchange determines the rate at which food particles and oxygen levels are replenished in the system. Depending on the tide, water exchange may vary dramatically over a fortnight.

The tidal volume is equivalent to the tidal height times the area of the basin. Water exchange is calculated as the tidal volume divided by the volume of the basin. Over a month's time, the water exchange in the basin at Whitehead varied from 29 to 63 per cent exchange per day or from 0.9 to 1.7 X $10^6 m^3$ (Figure 3). In addition, we estimate the river input at 0.05 X $10^6 m^3$ per day or approximately 4 per cent of the average tidal exchange. The extent to which the incoming water mixes with the resident water depends on factors such as the shape of the basin and the direction and strength of the wind. If the incoming water mixes completely with the basin water, then exchange is effectively a direct index of food supply. However, it is unlikely that complete mixing occurs in the basin so we have assumed a mixing value of 75 per cent at every tidal cycle. This means that the mussels can gain access to 75 per cent of the particles delivered during each tidal cycle.

CARRYING CAPACITY

From our data on water exchange, mussel food intake and food levels, we can estimate how many pounds of mussels this system will support from May to December (Figure 3). As expected, a greater number of mussels can be sustained in the spring when food levels are highest. From this graph, we estimate carrying capacity at roughly 3.3 million pounds, or the lowest weight of mussels sustained by the system over these months.

An alternate approach can also be used to estimate carrying capacity. If we allow the mussels to filter 50 per cent of the incoming water at a rate of 40 litres per day, the lowest water exchange, this system would support 3 million pounds. This would be equivalent to stocking the basin with 250 longlines, each 100 m long with 300 socks yielding 40 pounds each. At present, there are approximately 40 longlines in the basin, which, according to our estimate, is well below the carrying capacity of the system. Profiles of food concentration in the basin confirmed our conclusion that these mussels were not having a significant impact on the available food levels.

The Boughton River system on P.E.I. is 10 times the surface area of the basin at Whitehead. We estimate that over a month, the exchange varies from 25 to 49 per cent or from 8.3 to 15.9 X $10^6 m^3$ of water. By using the filtration rate method, i.e. 40 litres per day and 50 per cent of the incoming water being filtered, we estimate the carrying capacity to be 34 million pounds. This would be equivalent to stocking Boughton River with roughly 2,500 longlines, with each 100-acre lease yielding a maximum of 3 million pounds.

CONCLUSIONS

The approach used in this study to estimate carrying capacity has several limitations. For example, the calculations assume that the mussels are evenly distributed in space throughout the basin. However, the validity of this assumption depends on the density of mussels per sock, the number of socks per line and the spacing between lines. These factors are significant and need to be quantified in order to improve our estimates.

Given that most estuaries have food levels greater than 0.5 mg/l, water exchange seems to be the critical factor to be considered in selecting a site. This was well demonstrated in studies on the Magdalen Islands where very low tides (10 cm) are associated with a low carrying capacity.

FIGURE 1

FOOD LEVELS

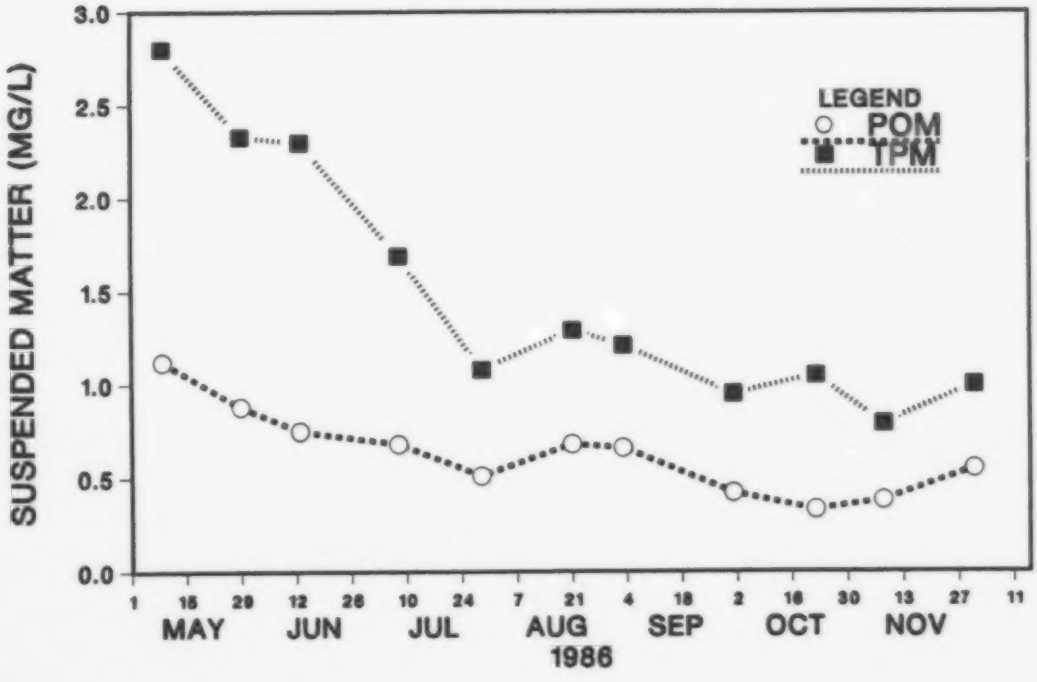


FIGURE 2

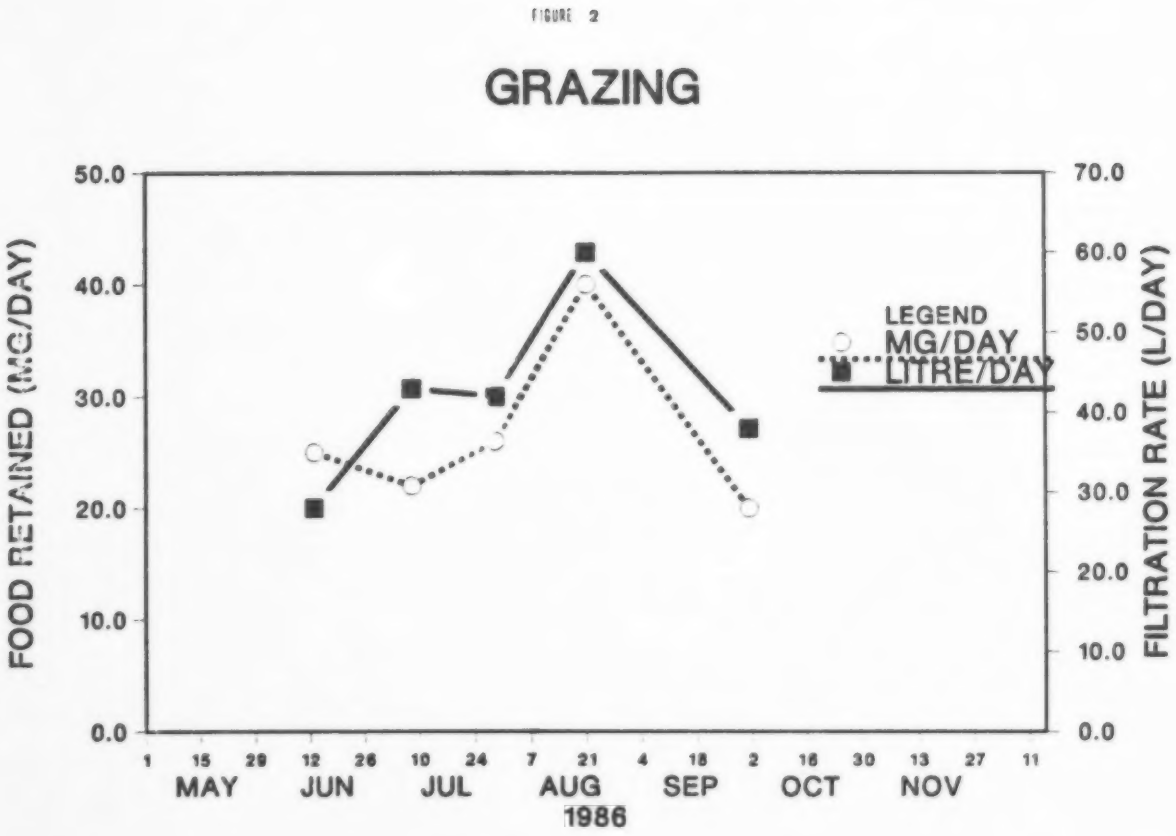
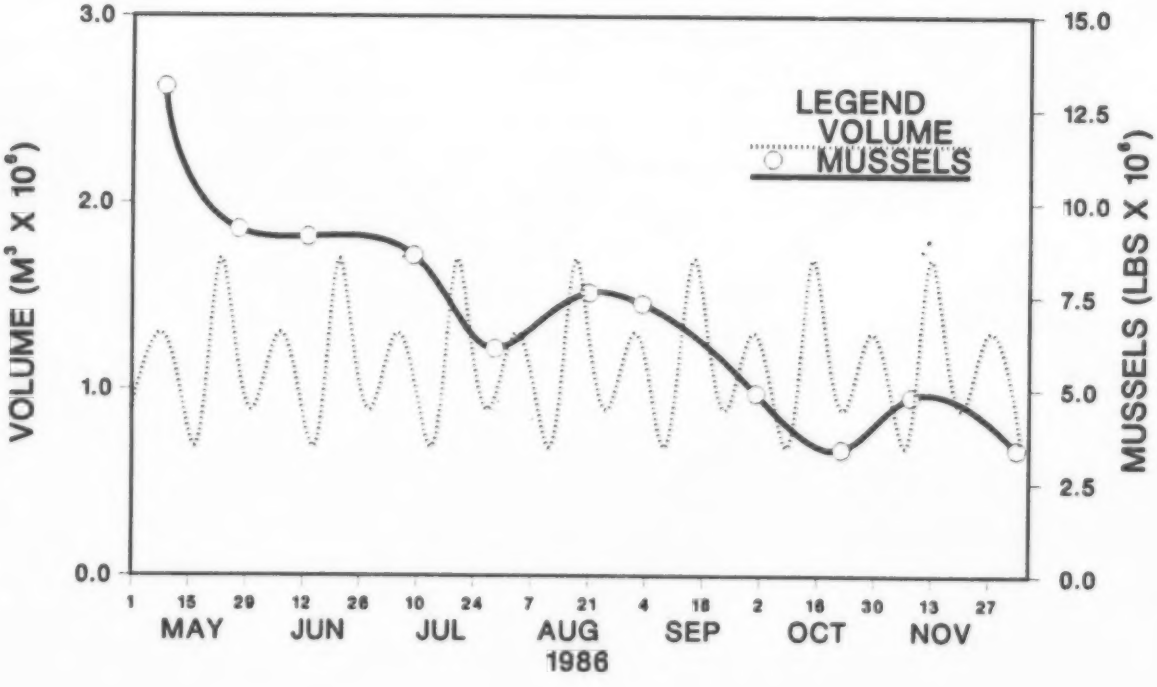

GRAZING
FOOD RETAINED (MG/DAY)
FILTRATION RATE (L/DAY)
50.0
40.0
30.0
20.0
10.0
0.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
LEGEND
MG/DAY
LITRE/DAY
1 15 29 12 26 10 24 7 21 4 18 2 16 30 13 27 11
MAY JUN JUL AUG SEP OCT NOV
1986

FIGURE 3

WHITEHEAD



INTENSIVE CULTURE AND PRODUCTIVITY

by

Wayne Somers

Mussel Grower,

Atlantic Mussel Growers' Ltd.

Murray River, P.E.I.

How many mussels can you produce per acre? I believe no one really knows. Every lease has its own conditions, including water exchange and other factors, but we can make certain assumptions based on what we do know. In Europe, for example, a good bottom culture site can produce 22 tonnes of mussels per acre, which yields about 6,800 kg of meat. That would work out to about 15 lines per acre with our longline system. At that rate, we don't feel we would be hurting the environment, and the water column should be able to support it. Also, with a 100-acre lease on a two-year cycle, 2 1/4 to 2.5 million pounds a year could be produced. Nobody on Prince Edward Island is at that volume yet but, in a couple of years, we should be. There will be at least a few growers of that size and when they want to expand, they'll bring in biologists to do site analysis to see just how much more they can produce.

My presentation is divided into three sections:

- anchorage systems;
- increasing production; and
- timing.

ANCHORAGE SYSTEMS:

Anchorage used depends on bottom type. On P.E.I., we are fortunate to have a lot of mud bottom. Our favorite anchorage here is the half 45-gallon drum. When we cut them, you don't use torches. A pneumatic chisel or air chisel can cut a 45-gallon drum in half in seconds. They are then filled with concrete, 7 1/2 barrels to the yard, which works out to about $10 an anchor. They weigh about 700 lb. and we insert a piece of rope with which to attach our scopes.

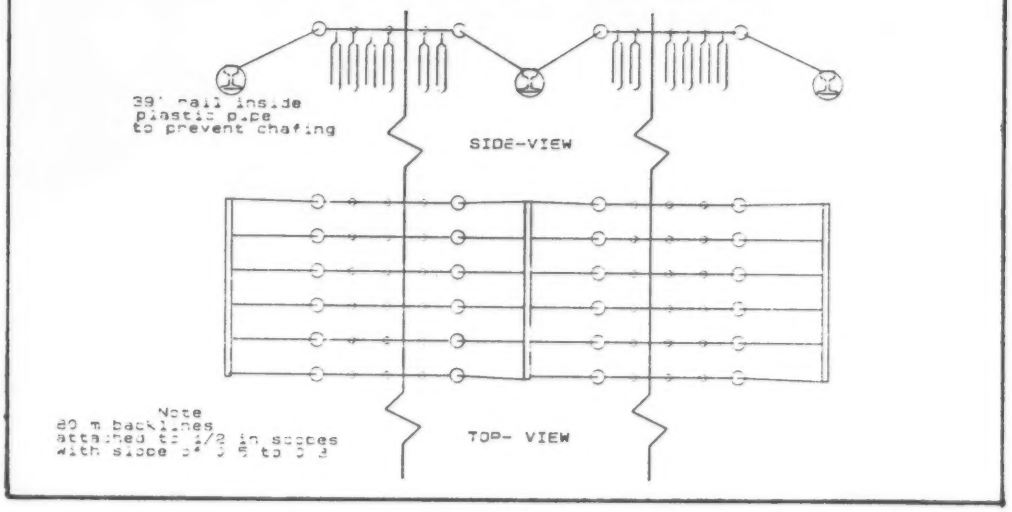
We have found that when placing our anchors, much of the time we don't know how they land on the bottom. They might be upside down or sideways, and the scope can chafe on the side of the anchor and, in the second year, break. When this occurs, we lose mussels. So we get a piece of 3/4-inch water pipe, 2 feet long, and shove it tight against the knot on the anchor and pin it with a galvanized nail. All the chafing is, therefore, on the plastic, and we've never had a broken line since we've started doing this.

A couple of years ago, we tried using iron rails (normally used for railway tracks) for anchorage. Three such rails are referred to as BLOCK UNITS (also known as UNIBLOCKS).*

* Note: Rails are usually 39 feet in length. The size and, therefore, the weight of the rail used in mussel growing, however, may vary. A rail is sized in pounds per yard. Thus, an 85 lb. rail weighs 85 lb. per yard or 1105 lb. per rail length.

Figure 1

RAIL-ANCHORED MUSSEL CULTURE SYSTEM



The system has worked well and, during 1987, we are installing more of them. To prepare a rail for mussel culture, we cut holes in it with an acetylene torch, and use shackles and chain, cut two feet in length, to allow for chafing. We're going to try to tie the ropes right to the anchors because the shackles and the chain are expensive. We may also use a piece of plastic pipe (ABS) in case the anchor rolls while being set. I'm fortunate enough to have a 45-ft. boat, so they are easy for me to place. I simply put logs across the boat and drop the anchors over the side using the boom. Some people have used rafts and some have put the rails on the beach, attached their scopes at low tide and, when the tide cames in, floated them out with barrels and placed them that way. Everybody has his own method. When you install them, if you want them 80 yards apart, you run a backline to get the right distance.

The chief advantage of the rail system is apparent: increased production per acre. You're getting your lines as close as the lease permits. We haven't found too many disadvantages, except that the lines have to be tight. You have to go back periodically, as the rope stretches, and tighten the lines so they don't come together at low tide.

In most cases, the least expensive anchor proves best. I would recommend staying away from custom-made steel anchors. Although they may work well, they are not cost-effective unless you have long-term financing and, as most mussel growers know, that is hard to come by.

A hundred-line farm (per year) means 200 lines in the water, and it will require 300 anchors. This is an investment of $4,500 at $15 per anchor. Anchors will not be tested until the second year. If the anchor drags, the lines tend to circle and, within a few hours, the mussels will rub off, which can cause a loss of up to 100 per cent.

INCREASING PRODUCTION:

There are many ways to increase production per acre. I will discuss a few.

In attempting any increase in production, a farmer must know his lease well, (bottom type, water flow, and wave action, etc.).

The rail discussed above is becoming very popular in some areas as it produces a lease that is neat and well-organized, with lines as close as local conditions permit. We're running our lines about 8-10 feet apart. You could probably reduce that to 1 metre with the proper conditions. I have no immediate concerns about over-production per acre with the longline system. It doesn't approach the concentration levels of the raft system being used successfully around the world, with high tonnages produced per acre. But one should remember to stagger these block units so as not to have a high concentration of market mussels in one area.

High yields begin at the stocking table. In the beginning most people are guilty of overfilling socks. This causes slow growth, fall-off and added stress. Others will underfill, which may give good growth, but low yields and fouling problems. This is where experience pays off, in knowing how many mussels per foot are needed in the sock to suit your particular lease conditions.

Spacing the socks can increase yield per line, as well. The rule-of-thumb used to be a 100-yard line with 100 socks, but, by putting socks two feet apart, 150 socks can be placed on the same line. With 150 socks on a line, we had problems with anchors holding, so we cut back to an 80-yard line with a two-foot sock spacing.

When raising new crop lines in the spring, you have an opportunity to add floats and to inspect each sock visually. An overcrowded sock should be thinned but, in most cases, "sticking" the sock at this time is best. We use 1/2-inch plastic pipe, cut into 1 foot lengths. We have found, on average, that lines which had socks with sticks through them have had yields 25 per cent higher than the ones without. We use five to 10 sticks on an eight-foot sock. While harvesting these lines, we have found that the mussels "walked out" onto the sticks, making it easier for them to get food but, most importantly, the sticks have added structural strength and reduce the August fall-off problem.

TIMING - KNOWING WHEN TO DO WHAT:

Once again, this comes from experience, but that can be a costly process. So here are a few examples.

COLLECTORS

It is important to know when to put collectors out. If they are put out too early, there may be fouling and loss of the set. However, I would rather be two weeks early than two weeks late. If you miss that big first set, it's unlikely that you will get another of sufficient quantity.

SOCK FILLING

We have found, at great expense, that we cannot fill socks in September or in the first weeks of October, due to the fall set. If the timing is wrong, new socks act as collectors and become extremely overcrowded with second set. Spat monitoring is very important at this time of the year. A drop in water temperature indicates that mussels have stopped spawning, so, after approximately 10 days to two weeks of dropping temperature, it should be safe to hang socks.

STICKING

We have found that sticking in our area can only be done during the first month of spring. Once the water warms up in late May and June, mussels become lazy and will not walk out onto the sticks. This is a problem, but it doesn't have to be, if work is done before the water temperature rises. On the mainland, where water temperature doesn't rise like it does here, you may be able to stick all summer. But one has to remember that mussels become inactive in cold water also. The ideal temperature for sticking socks seems to be 5 to 10°C.

Two years ago, we did our first prototype lines. We sticked 25 to 30 lines and the yields increased 25 per cent. We produced a 300,000 lb. crop, and an additional $35,000 for my pocketbook. My partner, Ralph MacPherson, and I bought 15 miles of plastic pipe, invested $9,000, including labor, but produced $35,000 in extra returns.

PREDATION, DISEASE AND MORTALITY

PANEL

NAME	AFFILIATION
Peter Darnell	Indian Point Marine Farms
Dr. Andre Maillet	Bedford Institute of Oceanography
Dr. R.J. Thompson	Memorial University
Dr. Gerry R. Johnson	Atlantic Veterinary College

POST-SPAWNING MORTALITY - AN HYPOTHESIS

by

Peter Darnell

Indian Point Marine Farms

Mahone Bay, Nova Scotia

Before I speak on predation, disease and mortality, I must confess that I have no academic qualifications in this area. However, I have made observations for five years while running a mussel-growing operation in Mahone Bay on the South Shore of Nova Scotia. During that time, we have had problems, large and small, and I have tried to find possible explanations. Of course, it can be difficult because the growing cycle and other circumstances can be substantially different from year to year.

We have two major predators, starfish and crabs, (both green and rock crabs). We have a set of starfish every summer, but they are only a problem when they occur on the new collectors. In any case, they are removed when the collectors are stripped and the mussels put into socks for growout. The one-year-old mussels are large enough that the new starfish set causes no difficulties. Crabs are only a problem when the socks touch bottom.

We are seeing signs of a potential problem with ribbon kelp which anchors to the mussels and can grow with great speed. This causes congestion in the socks and the mussels can then migrate out on the kelp and fall off. Time will tell whether this will develop into a serious problem.

Our company has experienced, to a greater or lesser degree, post-spawning mortality each year that we have been in business.

This occurs almost immediately after the mussels spawn, in our case, any time after June 10. The degree of mortality has varied from an almost negligible 2 or 3 per cent, to as high as 25 per cent (1986).

This recent experience was our worst to date. The first sign, occurring immediately after spawning, was the seemingly overnight deterioration of the byssus attachment. Any disturbance at all of the mussel socks led to mussels falling off. Indeed, harvesting at this time had to be done with a net. Within a week of harvesting, dead mussels were showing up on the grading belt.

The loss, whatever percentage it might be, is a problem, but the major inconvenience is separating dead mussels from healthy ones after harvesting. The dead ones do not open, but remain fairly tightly closed, with vile-smelling, decaying tissue inside. The only means of identifying them is by individual handling, a very slow and expensive process, and, basically, ineffective as, inevitably, a few get by.

We have taken some of these mussels to the Fish Health Laboratory in Halifax and nothing other than normally-occuring bacteria was identified. No known diseases were apparent, although DFO staff readily admitted that both the literature and their own experience offered little information on the subject.

Another critical observation was that only two-year-old mussels, presumably sexually mature, were affected. The one-year-old, or juvenile, mussels seemingly thrived throughout this period. Another anomaly was that here and there, at random intervals along the lines, there were healthy socks.

It should be noted that we grow mussels on three different leases no more than a half-mile apart and separated by islands, but mortalities occurred similarly at all three locations.

Mussels continued to die without interruption until approximately mid-August. By mid-September, the remaining mussels were growing rapidly and producing exceptionally large meat yields for that time of the year.

The dead mussels were almost completely deteriorated and no longer presented a grading problem. The declumper/grader would crush those shells and eliminate the problem.

Faced with these widespread mortalities, we had to try to identify the reasons.

First, during the summer of 1985, particularly slow growth of that year-class of mussels was observed. Mussels are normally 80 per cent market-sized by December. However, when spawning time arrived in June, 1986, only about 50 per cent were market-sized. Were they already in a weakened condition due to lack of food when spawning took place?

Second, we were trying to grow more mussels on our lease than in previous years. Were we outstripping the carrying capacity of our lease? What is the carrying capacity of the lease and how does this vary from year to year?

Third, why were other growers, both in the same bay and in neighbouring bays, not experiencing similar problems? Was it because we were bringing in seed from a different site further east along the coast, while they were using local spat, or, again, was it because we were growing in higher concentrations, trying to get the maximum yield out of a given area of water?

Our main hypothesis (to which we are not too firmly committed) is that, in certain years, spawning takes place at a time coinciding with a period of very low food levels in ambient waters. The mussels, perhaps already under stress by a severe winter, spawn, and find themselves weakened, with no food supply to revitalize themselves. Hence, a natural thinning process occurs, followed by a new feeding cycle, during which the surviving mussels regain their vigor and life goes on.

This hypothesis leads to several different strategies to avoid mussel mortality.

The first plan is to simply thin out the densities at which the mussels are being grown: put fewer mussels in the socks, put the socks farther apart on the longlines and space the longlines more. This would give the mussels greater access to the food supply. We must remember they can filter two to five litres of water per hour, that is, one nine-foot sock can filter 7,200 litres of water per hour, or 172,800 litres per day.

Another approach is to manipulate the spawning times. This can be done by keeping the mussels in deeper, colder water until harvesting, thus postponing the spawning time. I have even heard of inducing them to spawn earlier than normal by placing mussel spawn in the surrounding water. In this way, spawning would occur when food supply is higher.

Another strategy is to experiment with different seed stocks and find the one most resistant to mortality, perhaps because it is hardier all around or perhaps because its spawning time is different.

Finally, there is the possibility that summer harvesting should not be attempted. Leave the mussels in the water until September when the problem will be past; the dead mussels will be gone and the natural thinning process complete. Better yet, sell that crop of mussels before mid-June and avoid the problem entirely.

An article on "Raft Culture of Mussels in Galacia" (Proceedings of the Symposium on Blue Mussel Culture, March, 1986) by Antonio Figueras refers to conditions which bear some similarity to those which I have described. I quote,

"Microscopic inspection of sectioned byssus material from Mytilus galloprovincialis from Italy revealed fungal hyphae throughout the byssus stem (Vitallero & Zucarello, 1973). It seems possible that such fungal breakdown of the byssus could interfere with the mussel's ability to attach firmly to the substrate. Mytilus edulis from Dutch waters was found with similar manifestations, degradation of byssus threads, followed by weakening of the shell ligament and blackish discoloration of the mussel's soft body."

I think, at the very least, detailed analysis of possible diseases needs to be carried out before we accept the premise that this mortality is stress-related and not a disease problem.

Those are some of the frustrations we have encountered, being faced with problems to which we are unable to apply intelligent solutions because of a serious lack of information regarding the growing conditions of mussels. Because we lack even a rudimentary monitoring system, we are unable to attribute problems to certain specific conditions. In order to find effective husbandry techniques, we must be able to see the larger picture. Of course, accumulated data in the short term is interesting, but not very useful. As the data builds up, perhaps patterns will emerge, differences will be noted, and problems may be anticipated and avoided as maximum carrying capacities are established and followed.

Some of the factors that need to be monitored include water temperature and stratification, current velocity, water transparency, salinity and the amount of dissolved oxygen. The mussels should be monitored for spawning times, condition index, fouling organisms, predators and parasites. Food availability needs to be measured, including factors such as chlorophyll levels, phyto- and zooplankton numbers and particulate organic matter.

Only with a better understanding of the cycles and patterns in our local sites will we be able to be most effective in growing mussels. However, we must remember that increased knowledge will not alter the fact that we are farmers, and that good years and bad years are as inevitable as the rise and fall of the tides.

MORTALITY PATTERNS: INFLUENCE OF STOCK, SITE AND SEASON

by

Dr. Andre Maillet

Independent Researcher

Bedford Institute of Oceanography

INTRODUCTION

In contrast with salmon and trout farmers, most mussel producers do not exploit the genetic differences among wild stocks. Several studies have shown that mussels from different geographic origins can have different growth and mortality patterns when grown at the same site. In this presentation, the effect of genetic stock, site and season on mortality is discussed.

METHODS

The mortality study was designed as follows. Juvenile mussels from 11 different stocks were transplanted to nine sites along the coast of Nova Scotia in November, 1985 (Figure 1). Two replicate cages of 150 juveniles from each stock (2 replicates X 11 stocks or 22 cages) were suspended from a longline at each site. In December, the longlines were submerged below the surface to a depth of 2 or 3 m off the bottom. In mid-April, we refloated the longlines, counted the number of mussels in each cage and standardized the number at 125 per cage. We repeated this sampling procedure in early July and mid-September, reducing the number of mussels per cage to 100 and 50, respectively. Our final estimates of mortality were obtained in early December, 1986. From the mortality data on each stock at each site, we calculated the mortality for each season and the cumulative mortality for the year.

RESULTS

The total cumulative mortality of all stocks and sites between November, 1985 and December, 1986 was 19 per cent (Table I). Averaged over all sites, stocks E and F exhibited the highest mortalities, 57 per cent and 39 per cent, respectively (Figure 2). The other nine stocks showed cumulative mortalities ranging from 7 to 20 per cent.

Averaged over all stocks, the sites with the highest cumulative mortalities were site 6 (29 per cent) and site 1 (28 per cent) (Figure 3). Sites 2, 8, 9 and 10 showed mortalities of 18 to 20 per cent, whereas sites 3 to 5 had mortalities of 12 to 15 per cent. Specific estimates of cumulative mortality for each stock at each site ranged from a minimum of 2.7 per cent for stock J at site 9 to a maximum of 98 per cent for stock E at site 8.

The average mortality for all stocks and sites was 4.6 per cent from November to April; 4.4 per cent from April to July; 7.1 per cent from July to September; and 3.1 per cent from September to December.

During the winter (November to April), stock E exhibited the highest average mortality (29.3 per cent) (Figure 2). Stock G also showed some mortality (7.7 per cent); but all the other stocks had average mortalities of less than 3 per cent. In the spring period (April to July), stocks B, E, G and H showed mortalities ranging from 6 to 9 per cent; whereas the other seven stocks had values of less than 5 per cent. During the summer (July to September), stocks E and F exhibited mortalities of 13 per cent and 26 per cent, respectively. These values were considerably higher than all the other stocks which were less than 6.5 per cent. In the fall (September to December), stocks E (8.6 per cent) and F (6.1 per cent) again had the highest mortalities, with the other stocks showing less than 4.6 per cnet mortality.

Table I

Cumulative mortality of all stocks and sites from November, 1985 to December, 1986.

		SITE 1	2	3	4	5	6	7	8	9		
	A	13.7	4.8	6.7	7.5	6.5	16.5	6.5	7.3	12.6	9.1	S
	B	15.5	22.2	13.7	6.7	15.0	21.4	7.3	5.0	21.5	14.2	T
	C	40.4	12.6	8.1	12.7	9.4	15.6	11.1	8.2	4.4	13.6	O
S	D	14.0	19.7	8.5	5.9	14.4	15.6	10.6	2.7	12.8	11.6	C
T	E	15.1	18.5	9.3	9.4	15.6	18.6	6.5	15.9	9.7	13.2	K
O	F	47.1	34.1	24.6	34.3	14.0	97.2	98.0	92.1	68.9	56.7	
C	G	52.8	4.5	11.2	15.0	20.7	20.5	28.4	15.8	15.1	20.5	M
K	H	17.4	3.0	8.6	7.1	3.2	9.5	2.8	6.7	20.2	8.7	E
	I	61.3	64.6	38.3	33.7	13.0	46.1	15.4	42.0		39.3	A
	J	4.8	5.0	21.0	14.1	10.4	29.2	24.8	14.8	23.6	16.4	N
	K		12.2	6.9				4.9	4.7	6.3	7.0	
		28.2	18.3	14.3	14.6	12.2	29.0	19.7	19.6	19.5	19.1	

SITE MEAN MORTALITY (%)

During the winter, the mortalities at sites 7 to 9 ranged from 8 to 10 per cent compared to less than 5 per cent at the other sites (Figure 3). In the spring, the highest average mortalities were recorded at sites 1 (11.7 per cent) and 6 (8.9 per cent), with 1.8 to 4.6 per cent mortality at the other sites. In the summer, site 6 again exhibited a high mortality (14.5

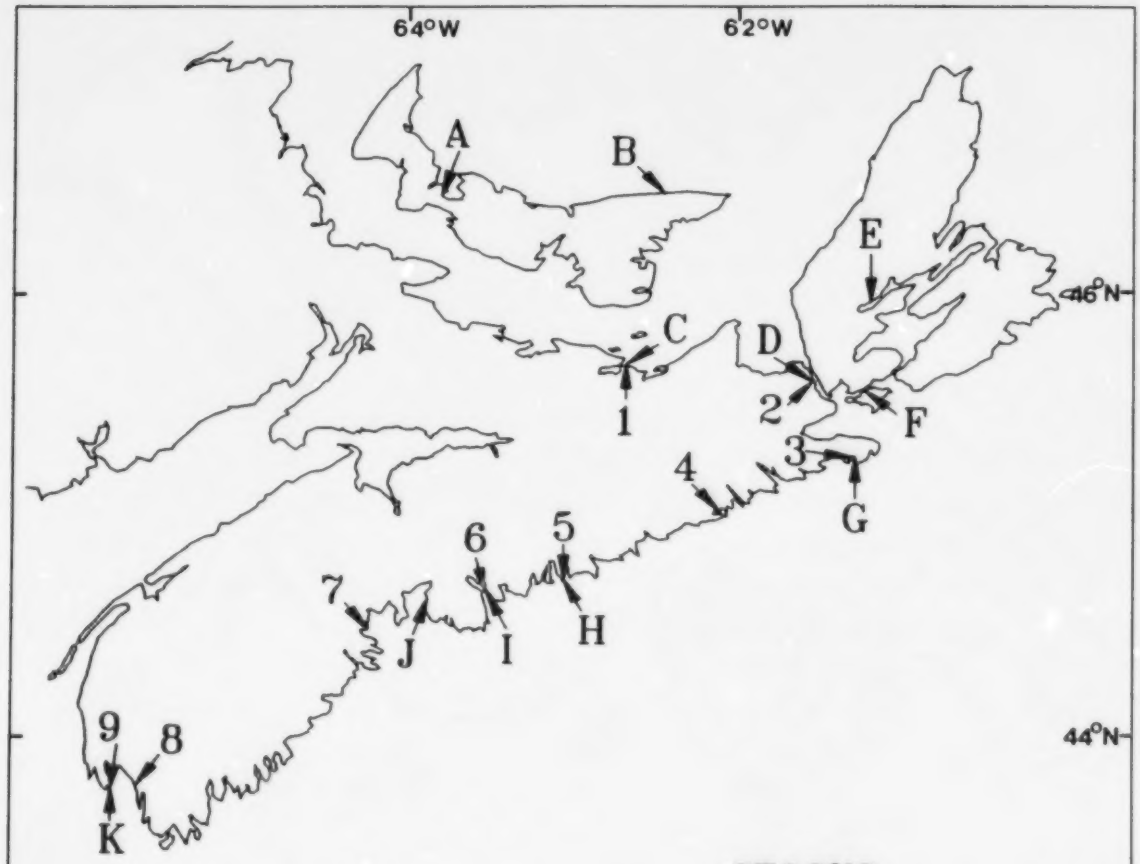
per cent) relative to the other sites (4 to 9 per cent). In the fall, average mortalities were less than 5 per cent at all nine sites.

CONCLUSIONS

Mortality is an important component of production. Mussels from different geographic origins have been shown to have very different mortality patterns. Eight of the 11 stocks, however, had similar over-all mortality levels, up to the age of 18 months. This supports the contention that mussels have a wide tolerance range.

Site alone did not seem to significantly influence the variance in mortality. The environmental conditions present at any given site were not better than those at other sites. However, the populations differed in their sensitivity to the environmental conditions present at the various sites or during the different seasons. The relatively lower mortality of Stock E at sites 1 to 5 compared to sites 6 to 9 is an example of this site-specific mortality (Figure 4). The particular sensitivity of Stock F to summer conditions is an example of season-specific mortality (Figure 2).

FIGURE 1



SITES		STOCKS	
1	CHANCE HARBOUR	A	BENTICK COVE
2	AULDS COVE	B	ST PETERS BAY
3	WHITEHEAD	C	CHANCE HARBOUR
4	SPANISH SHIP BAY	D	AULDS COVE
5	OSTREA LAKE	E	DENAS POND
6	BEDFORD BASIN	F	LOUISDALE
7	MAHONE BAY	G	WHITEHEAD
8	ARGYLE	H	OSTREA LAKE
9	WEDGEPORT	I	BEDFORD BASIN
		J	ST MARGARETS BAY
		K	WEDGEPORT

FIGURE 2

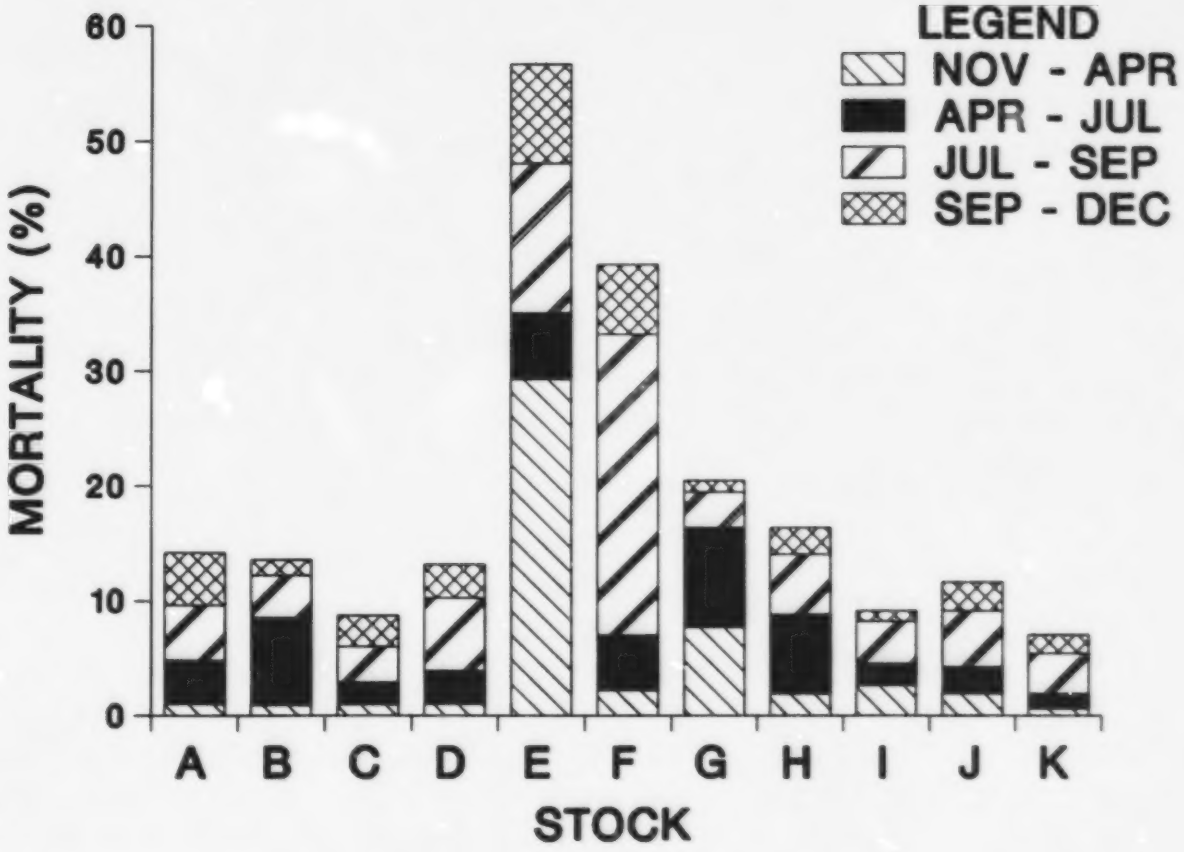

LEGEND
NOV - APR
APR - JUL
JUL - SEP
SEP - DEC
MORTALITY (%)
60
50
40
30
20
10
0
A
B
C
D
E
F
G
H
I
J
K
STOCK

FIGURE 3

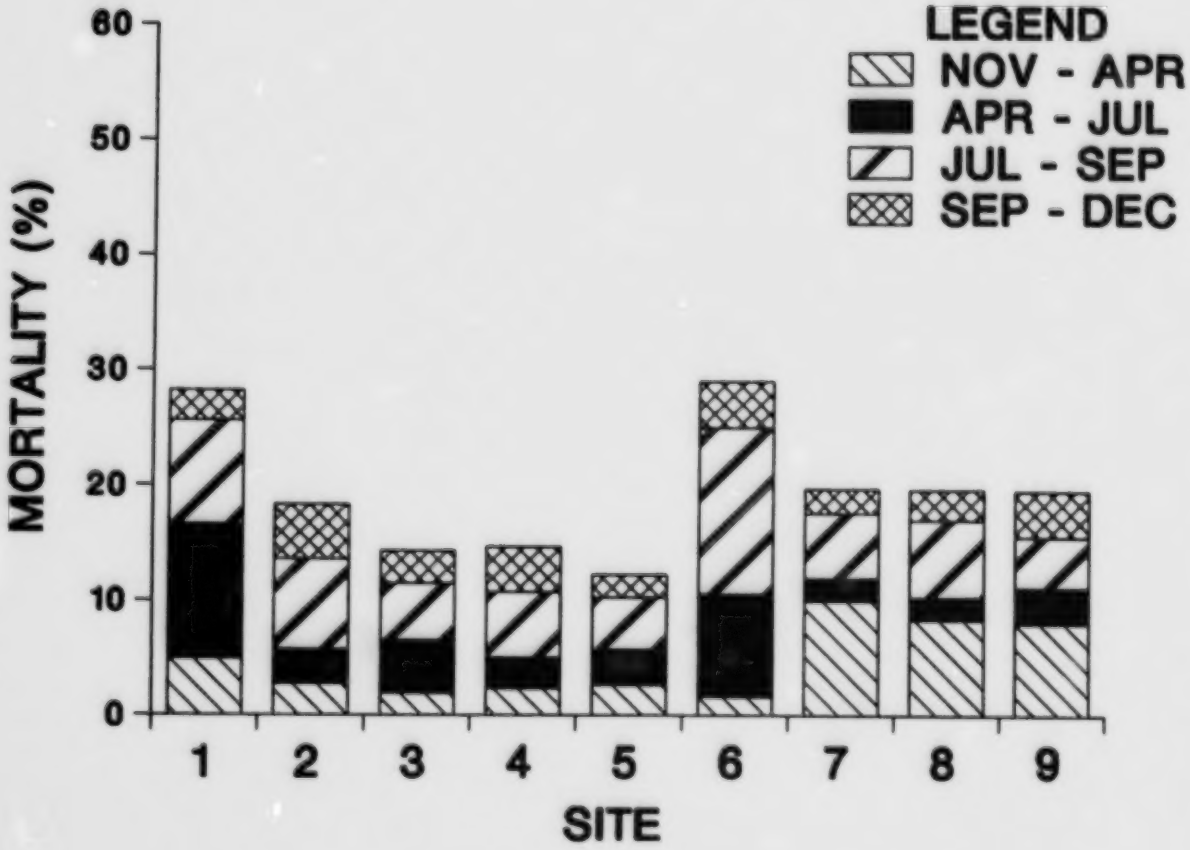
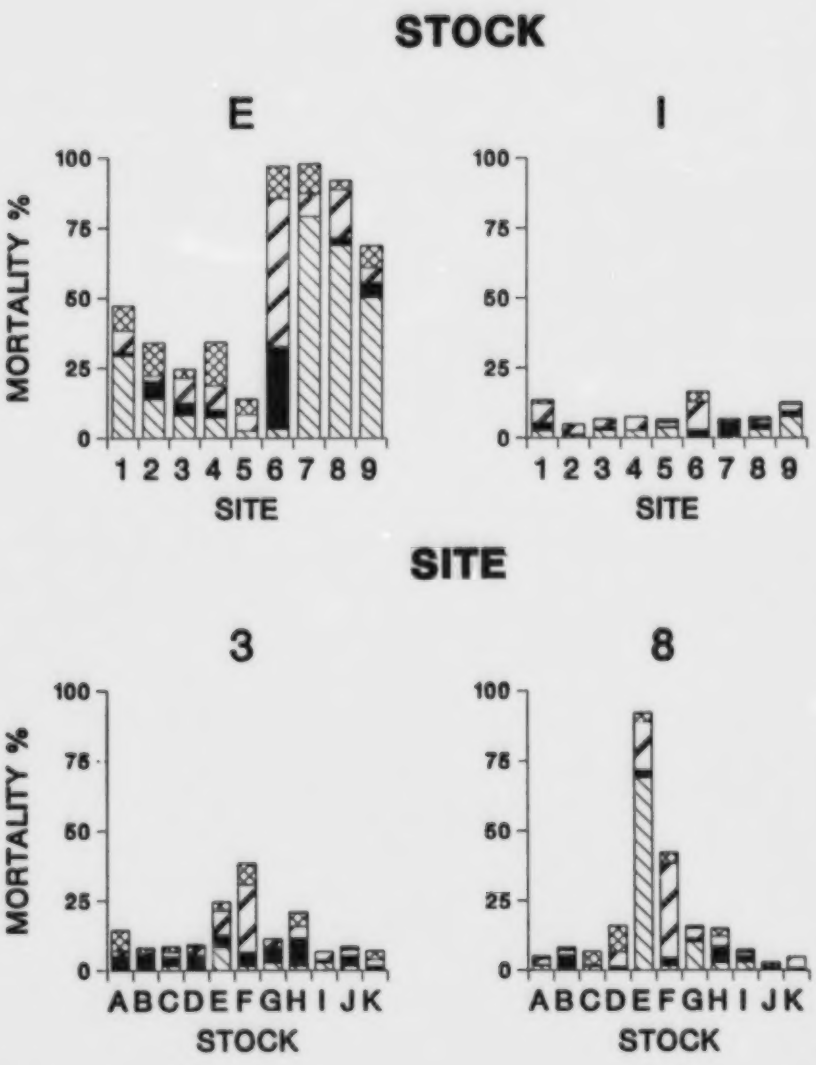

LEGEND
NOV - APR
APR - JUL
JUL - SEP
SEP - DEC
MORTALITY (%)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
SITE

FIGURE 4


STOCK
E
I
MORTALITY %
100
75
50
25
0
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POST-SPAWNING MORTALITY IN THE BLUE MUSSEL, *MYTILUS EDULIS*

by

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INTRODUCTION

Seasonal variation in mortality rates appears to be common in the blue mussels. Mortality is usually greater in summer than in winter, and often reaches a maximum during or immediately after spawning, although this is often not clear from the published reports. On Vancouver Island, for example, very high mortalities in mussels grown in suspended culture have severely inhibited the development of an aquaculture industry. High mortality in summer also occurs in Puget Sound, Washington (Skidmore and Chew, 1985), in Maine (Lutz, 1980), and in Nova Scotia (Freeman and Dickie, 1979), whereas in southwest England, mortality in *Mytilus edulis* is greatest during spawning in the spring (Worrall and Widdows, 1984).

During the summer of 1986, mussel growers in some parts of the Maritimes suffered unexpectedly high losses due to post-spawning mortality. This has created considerable concern in the industry.

CAUSES OF MORTALITY

There are many factors which may contribute to mortality in the mussel. Some are biological (e.g. predation, parasitism, senescence and poor nutrition) and others are physical (e.g. overcrowding, wave action, tidal scour, ice scour, high temperature, silt and low salinity). It should be noted here that longevity is reduced in areas where mussels grow rapidly,

which suggests that lifespan is fixed in terms of a developmental program, but that the rate of aging can be modified by environmental factors (Seed, 1976). Thus, we should expect cultured mussels to become senescent before those from natural populations in the same area, although this does not explain the unusually high mortalities recorded in certain years.

It is the high mortality associated with spawning which concerns us here. This phenomenon has received little attention from scientists, except for one study of a population of Mytilus edulis in an estuary in southwest England (Worrall and Widdows, 1984), which showed that the mortality rate tripled during the spawning phase in April. I have also observed high mortalities in mussels from Newfoundland after they spawn in June-July, so it appears that this may be a general occurrence. The timing apparently depends on the reproductive activity of the mussel, which varies considerably, according to locality.

STORAGE OF ENERGY RESERVES IN THE GONAD

In order to understand the physiological basis of post-spawning mortality, we need to know something about the structure of the mussel gonad. In Mytilus edulis, the gonad in both the male and the female contains specialized cells which store energy reserves, especially glycogen, a carbohydrate analogous to the starch found in plants (Lowe et al., 1982). During periods when food is abundant, especially the spring and summer (depending on location), the mussel accumulates glycogen in the gonad. Later, during gametogenesis, stored glycogen is metabolized as the mussel synthesises eggs or sperm. When the gonad is fully ripe, the glycogen is exhausted, but oxygen uptake is high because the gonad is metabolically active. After spawning, mussels have little or no energy reserve, a condition referred to as post-spawning stress, which results in some mortality.

THE ROLE OF TEMPERATURE

There are some indications that high temperatures may be responsible, in part, for mortalities in summer, but that is, by no means, clear. Thus, in southwest England, post-spawning mortality occurs in April, when water temperatures are well below 20°C (Worrall and Widdows, 1984), but in other regions, temperatures may be as high immediately after spawning, at least in some years. Although the upper lethal temperature for Mytilus edulis is 26-27°C, physiological stress is evident at 20-25°C, since the metabolic rate is high and feeding rate reduced at this level (Thompson and Newell, 1985). This is especially true in large mussels. According to Thompson and Newell (1985), post-spawning mortality is greater in Newfoundland mussels than in those from New York, if the temperature is above 20°C, although there is no difference in mortality between the two groups at lower temperatures. We may tentatively conclude that in some localities, in some years, the occurrence of high temperatures may increase post-spawning mortality beyond normal levels, but we cannot generalize.

THE PHYSIOLOGICAL BASIS OF POST-SPAWNING MORTALITY

Mortality occurs at a time when metabolic rate is high (owing to gametogenesis) but when storage cells are empty -- there are no nutrient reserves. Post-spawning mussels are in poor condition -- under stress. If gametogenesis and spawning occur when the water temperature is high, metabolic demand will be even greater, i.e. there may be a synergistic effect. If spawning is delayed, as it was in some parts of Atlantic Canada in 1986, stress will be prolonged, which can lead to greater mortality. In extreme cases, gametes may be reabsorbed to meet metabolic demands, although it is not certain whether this is common in the natural environment. If the food supply early in the year is poor (especially during the spring bloom), there may be less synthesis of glycogen than normal, which would increase stress later in the year and result in higher mortality.

MONITORING PROGRAM

Most of the analysis in the previous section is based on sound experimental evidence, but some is conjecture, since we have no data for environmental variables such as water temperature and food availability at the growth sites. A program to monitor the environment and the quality of the product (the mussel) is essential if we are to manage the resource and diagnose problems such as unexpectedly high post-spawning mortality. Water temperature and, possibly, salinity should be monitored, as well as selected properties of the food, i.e. the suspended particulate matter (e.g. chlorophyll, carbon, nitrogen, energy content, and weight loss on ignition). It would be useful to determine the spawning time, spatfall densities, somatic weight, growth rate and glycogen content of the mussels at selected sites. We know, for example, that the glycogen content of Mytilus edulis is variable (Bayne, 1984), and it would have been informative to establish whether the post-spawning mortality in 1986 was associated with unusually low glycogen levels.

The full benefits of a monitoring program may not be apparent for some years, but there are situations in which even a few simple measurements could help overcome certain problems. For example, if weather conditions could cause surface water to stratify, producing temperatures above 20°C, it may be possible to move the gear into deeper, cooler water. In situations where glycogen reserves are poor, perhaps as a result of low food levels, it may be appropriate to harvest more mussels than usual, in anticipation of heavy mortality. In the future, some growers may be able to place mussels at optimum depth to take advantage of the spring bloom, which normally begins at the surface and gradually sinks, depending on local conditions.

Mussel cultivation in Atlantic Canada is at an early stage of development, but it is desirable to set up a monitoring program and baseline data as soon as possible. In this way, the resource may ultimately be managed, as well as many agricultural systems today. Since the industry is

active in an area covered by four or five provincial jurisdictions and three or four different regions of Fisheries and Oceans, it may be appropriate for this monitoring and data management role to be assumed by a university, which could also advise growers, and would have the advantage of providing continuity.

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PREDATION, DISEASE AND MORTALITY

by
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The Atlantic Veterinary College is a new institution, and we are new to shellfish and mussel diseases in particular.

The points raised by the other speakers -- water temperature, chlorophyll levels, food levels, and predators -- are not something we would directly deal with from the standpoint of disease, but we would require that information in detail and assembled in a usable pattern, in order to figure out what's happening in the mussel itself.

Disease is a process. It is not stagnant. It is not simply a matter of finding symptoms and saying that a disease has occurred or has not occurred. Disease has a characteristic train of symptoms. The symptoms allow us to identify the disease. In the case of animal production systems, unless the disease is affecting production, either by mortality or by poor growth, it's probably something that isn't going to cause any great concern.

The second thing that I want to point out is that an agent is not necessarily an infective agent. An agent is any insult that lives in, and causes damage to, a tissue. Previous discussions point to a wide variety of delivery systems -- delivered agents, transmitted infectively by water currents, by starfish or by other carriers. Perhaps they are inherent in the spawning process and transferred with the gametes themselves. An agent is not a disease; it is something that is simply there. You can have fungus in byssal threads and, if the byssus is strong and the mussel remains on the sock and can be processed, it is not a problem, but if you get deterioration and mussels fall off, then that fungus becomes more important. It becomes

an agent generating a characteristic train of events that we can trace, identify and observe repeatedly. This enables us to predict that if some event occurs, on the basis of experience, you've only got so long before you're going to get weakness on the sock, for example, and it will affect your production and harvest.

Record-keeping systems are indeed important to control disease. It becomes a very important factor in trying to interpret disease or in trying to identify predictive factors among those agents you have identified. I stress that those agents can cover a wide range, including toxins, pollution and infective agents. Record-keeping is designed to "almost" prevent disasters.

If we were, for example, to do a lot of work on a particular problem in mussels, and we do have the capability to do very highly technical work in terms of electron microscopy, in terms of growing and identifying infectious agents or parasites, etc., and if we were to take the results and apply them to a mussel lease, and say we've found your problem, you can see right away that there are a variety of things that can go wrong. One of those is a problem of spurious correlation. If I sample a mussel lease where the hydrographic conditions are different from another area of the same lease, or if I sample from an area that has a large number of socks closely clustered together, it doesn't reflect what is happening in an area that is far more sparse. Taking the results from one area of a lease or from one sock and transferring those results into any sort of predictive model or any sort of disease model could, in fact, leave you with difficulty in interpreting it. You may make decisions which are economically disastrous because those samples do not reflect what is going on in the remainder of the lease.

Therefore, it is important that the records you keep as a producer, as well as the biological and meteorological records that are kept by other professionals, are available for interpretation. In this way, the area you are dealing with is either properly identified or the sample used is broad enough to represent the entire lease. A production site is always difficult to sample. If you try to take every mussel and sample it, you have an impossible task. If you take too few mussels to sample, you can't interpret the results and, so, consequently, you have to find statistical methods of getting representative samples of defined areas. These samples may be from areas within one lease or they may be from areas of a particular estuary.

We can, at the Atlantic Veterinary College, deal with a wide variety of chemical and microbiological techniques that are available for use in the mussel industry. We intend to pursue these avenues to the best of our ability and, in co-operation with other scientists, to acquire all of the available information in the manner I have described. Our main emphasis is disease, but we require information in order to utilize and interpret what we have. Cellular interpretations tend to be quite boring. There are only so many organelles within a cell. There are only so many things that can happen there. So that level of interpretation tends to be fairly easy to adapt to from our point of view. However, each cell has a different purpose. For example, one may be for keeping energy stores, and another for processing. If these cells don't get along, we start getting poor interactions between them and the delivery system. This causes problems when interpretation of cell-to-cell interactions within the mussel are what we use to develop predictive factors. If we can develop predictive factors, then we can correlate them with other information from other professionals and use it as a tool to suggest management strategies, eg. the mussels should be harvested earlier, or later, or that a certain type of disease has only a small chance of infecting a whole sock and that you should just put up with it.

As veterinarians, we have become quite familiar with information processes, and I think we can offer some good ideas here. The problem with information processes is that you need a great deal of background data, background work and experience in order to develop them. But that is one of the areas we hope to be heading into at the college.

In closing, I would just like to stress that, in fact, finding agents and diseases is not really so difficult when you have the material with which to do it. But interpreting data in a useful way for mussel production is a much more difficult task and requires that the information sources of all professionals be filtered through one central agent or agency. The ultimate decision-maker is, of course, the producer. Consequently, the information that is gathered or generated should be funnelled to and through him.

PANEL
DISCUSSION PERIOD
on
PREDATION, DISEASE and MORTALITY

The following points were raised during the discussion period which followed the presentations on predation, disease and mortality:

- mortality rates;
- sampling procedures;
- data bases (information).

MORTALITY RATES:

There has been no correlation observed between the success rates of a given stock in its place of origin as compared to a stock that has been moved to a new site with different characteristics. There is a negative correlation, however, between mussels coming from a favorable environment (a higher mortality rate) when they are placed in a set of environments as compared to those which originate at an unfavorable site if placed in the same set of environments.

Mussels are capable of adapting to changing temperatures, although it is generally accepted that 26 or 27°C is the upper limit. It is possible, however, that post-spawning mortality could result at a lower temperature when this occurs in conjunction with other factors. One experiment described dealt with an environment with a temperature above 20°C during spawning or immediately post-spawning. Mussels from Newfoundland in this instance were more susceptible and suffered higher mortalities than mussels from Long Island Sound. Although the temperature was below the lethal level, a combination of other factors caused higher mortalities in the Newfoundland mussels.

The amount of time mussels can be safely held in fairly cold water, if spawning is delayed, is not known. Estimates range from a couple of weeks to a month or even longer. This must be determined experimentally in each location. One important application for a monitoring system would be to predict post-spawning mortality. It might prove that mussels could be harvested before they spawn. That, of course, would also depend on market conditions, but it is within the realm of possibility.

SAMPLING:

Opinions varied as to who should be responsible for sampling: the growers themselves; a joint effort of government agencies, universities, or private agencies. However, it was agreed that there must be one central co-ordination centre where all the data and information could be made available to mussel growers on request.

In response to the suggestion that growers be responsible for the collection of samples, including live mussels, temperature, salinity and water samples, chlorophyll levels and POC (particulate organic carbon), etc., it was pointed out that this is time-consuming, expensive and requires considerable expertise. If this were to happen, an education program would be needed to teach growers the techniques involved. The necessary equipment is relatively inexpensive -- $1,500 would likely cover all the equipment required. It was generally accepted that analyses of samples should not be done by the growers themselves. Instead, water samples could be put on a glass fibre filter and shipped for analysis. It seemed apparent that growers would be willing to invest money and time for sampling, if they knew what had to be done to ensure a successful crop.

DATA BASES (INFORMATION)

Aquaculture is a relatively new industry. Like agriculture before it, lack of information and contacts creates many problems. At this point, there are still many unknowns. However, growers want the information we do possess readily available, so that sources of assistance and expertise can be tapped.

AQUACULTURE IN ATLANTIC CANADA:
RISKS AND OPPORTUNITIES FOR INVESTORS

by

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For those of you involved in fisheries science and research, the term aquaculture is a familiar one and you are probably quite knowledgeable concerning it. Such is not the case in the Canadian financial and business community.

It is only recently, the past four or five years, that this emerging industry has caught the attention of outside investors, existing fish processors or even the banks as an investment opportunity. As with any new industry, it takes a long time to establish credibility with the fairly conservative financial community, but in my view, aquaculture as a serious business has come of age in Atlantic Canada.

I would like to address this subject, both from the viewpoint of an investor looking at an aquaculture-related proposal and from the perspective of the aquaculture entrepreneur trying to raise equity capital. My remarks will cover the following aspects:

1. possible sources of capital that might be available to the entrepreneur;

2. criteria used by these possible sources in assessing investment opportunities;

3. likely terms and conditions you will have to meet or have imposed on you if you require and accept a financial partner; and

4. my thoughts on where this industry is going over the next 5-10 years in Atlantic Canada.

First, let's look at the potential sources of available capital. In any new or developing industry, lack of risk capital is usually cited as an impediment to progress. Aquaculture is no different than many other infant industries that have gone through similar growing pains. Before investors are going to open up their coffers and extend financing, some track record or degree of credibility has to be established. Even early franchisees of McDonald's restaurants and companies developing personal computers, such as Apple and Atari, faced disbelievers, ultra-conservative bankers, and reluctant suppliers in the early years. These are common problems faced by just about everyone starting a new business, not just by those who want to get into aquaculture. However, one major disadvantage faced by beginners in the aquaculture business is the fact that a significant upfront capital investment is required, with absolutely no return for at least two or three years. This applies even if, in the end, the venture turns out to be highly successful. For that reason, alternative sources of available capital to the aquaculture industry are limited. This must be recognized at the outset by anyone wanting to start a business in this field.

The most obvious sources of capital and the ones you should look to first are your own personal funds and those of your family or friends (in the trade, we call this "love money"). If you have no money of your own, your next-best alternative is people who know you well and who believe in you. If you have money, but are not willing to risk it in the venture, then stop and reassess your plans. If you won't risk your own funds, why should anyone else? Most businesses in Canada get their start through personal savings, with help from family or friends.

Another level of potential financing is what we term "the underground venture capitalist". These sources include private investors such as doctors and lawyers, prominent local business people or private investment clubs with large incomes. They are always on the lookout for ways of even

losing their money rather than paying taxes. For example, it's usually high income earners who finance limited partnerships, flow through shares for mineral development, etc.

I should mention the role of government. Even though governments do not provide equity or risk capital directly, many companies got their start as a result of government-funded research or development projects. Of course, for fixed-asset purchases, there are government assistance programs available, but usually these require (and rightly so) private contributions as well. So make use of government programs where appropriate. But be realistic, and be prepared to invest private capital also.

The next level you might consider would be the more formalized sources of equity, i.e. venture capital and similar funds. There are many in this country. The Association of Canadian Venture Capital Companies, a group to which our company belongs, represents more than 100 venture firms which have made investments exceeding $1 billion over the past 10 years in Canada. These are sophisticated investors whose objectives vary from doing start-ups, right through to doing public issues. The minimum size of their investment can vary from $50,000 to $5 million depending on the firm.

Obviously each company has its own criteria for assessing deals, but I'll try to give you an overview of those which are fairly standard to all investors.

Before moving on to that, you may have noted I did not include banks as a likely source of equity capital. Banks should <u>not</u> be considered investors! They are lenders who extend financing based on the ability of a company to service and repay debt out of cash flow, and on the basis of collateral and security. For an aquaculture operation, particularly in the early years, there is no cash flow, so it is unlikely that a bank would get involved.

Let's move on to assessing a proposal by the prospective investor. If you are considering raising funds from the more formal sources I have just identified, then it is necessary to prepare a business plan. The plan doesn't have to be lengthy. It should be easily readible, clear and to the point. There are a number of subjects on which an investor would require information, and these should be covered in the business plan. Let me give you some examples of what I consider to be essential information.

Background

First, begin with a brief history of the company, describing its origin, its product line, and its future, (which is why you are seeking funding). Remember, the easier it is to read, the better. Don't load it up with technical jargon. You'll have your chance to prove yourself later, if the potential investor wants to pursue the situation.

Management

Next should come resumés on the key management personnel involved. Again they should be brief, covering essentials like education and work experience. This should reassure the potential investor that the operators of the business know their field.

Market

Another important area that should be addressed is the market or the competitive environment in which the company carries on its business. In many ways, the product lines in aquaculture are relatively simple - Atlantic salmon, mussels, trout, oysters, etc. Most people are fairly familiar with these species and the product should not require in-depth explanation. However, the approach you plan to take in marketing these species and an analysis of your competition are very important. Today we hear more and

more of the global economy, and I see numerous examples of how we are moving towards it, particularly as it relates to aquacultural marketing. For example, any long-range forecast on Atlantic salmon must take into consideration what the Norwegians and Scots are doing, as well as our friends on the Pacific coast in British Columbia. P.E.I., N.B. and N.S. mussels compete in the Quebec and Ontario market. Almost all of our farm-raised products are exported out of the region, so, in that sense, we are very much affected by competition over which we have little or no control. Free trade discussion only accents that reality. So all of these concerns must be addressed in this section of the business plan. Do you have a competitive advantage? Is there something unique about your product? In the case of P.E.I. mussels, I think a case could be made. They are of superior quality compared to others produced in the region.

Equity

A short section on current ownership and share structure is required. Obviously, a new investor is really a partner, so he wants to know "who he is getting into bed with!" If there are all kinds of inter-related companies and complicated shareholdings through a variety of different schemes, this will turn him off.

Financial

Next, there must be a financial section. If it is an existing company, then provide two or three years of historical financial data, including annual statements, if available. (Balance Sheet, Statement of Income and Expense, Cash Flow Statement. ed.) If these statements are audited, all the better. Many small businesses want to avoid the expense of going through an audit, but if you ever plan to raise outside equity or to seek proper bank financing, you'll end up having one done eventually. While history can be an indicator of the future, it is the projections or financial forecast that must entice new partners to get involved. Now I haven't seen a bad set of projections yet in any proposal sent to us.

Obviously, projections should be positive and demonstrate growth and adequate return on investment. But nothing turns off a sophisticated investor more than ridiculous projections, showing unbelievable revenues and profits over a relatively short time. It's tough to make a dollar, so please be realistic when estimating both revenues and expenses. Our experience has shown that most proformas (Cash Flow Statements) overestimate revenues and underestimate expenses. Murphy's Law is always at work, so there will be unforeseen problems along the way which could seriously affect cash flow. Cash flow, of course, means survival and, in a company's early years, it's even more important than profit and loss.

Financial Requirements

Another common weakness in most entrepreneurs' forecasts, is to underestimate the working capital required, until revenues are sufficient to cover expenses. As I stated earlier, this is particularly critical to aquaculture operations where 18-24 months can pass with no sales. Even when sales are made, one needs to collect the receivables, so there is a real need to be conservative when doing a cash flow forecast. On the other hand, if the projected results are not attractive enough, you won't be able to attract the interest of possible financial partners. You must realize, however, that most sophisticated investors are reviewing financial forecasts continually, from a variety of companies, so they are quite adept at zeroing in on the weak spots. Remember if you get their initial attention, they are going to put these numbers under further scrutiny. If it becomes obvious that your forecasts were thrown together without a lot of thought and substance, they'll blow you out of the water, fast.

Investment Proposal

Now that you have caught the investor's attention with your track record, product and market uniqueness, and potential profitability, you should end the business plan with a specific investment proposal. You should identify exactly the level of funding you are seeking, identify the sources, if there is more than one, and clearly identify how the funding will be used. You should at least propose terms, i.e. how much of the company you are prepared to sell, as well as suggesting the structure of the deal to be made. By doing this, the potential investor at least knows your thinking, and can assess from the beginning whether or not you are being realistic, and thus serious. Our experience has shown most entrepreneurs over-value their companies and their potential and, therefore, are not very realistic when seeking outside investment. For that reason, I strongly suggest you remain flexible when the negotiations begin, and be prepared to compromise. I have seldom seen a deal that once completed, closely resembled the original proposal.

Let's quickly review how an investor assesses the risk and the kinds of conditions he will attempt to negotiate in any deal.

Obviously the investor wants as large a piece of the pie as he can get because, if the company is successful, it is through capital gains that the real money will be made. Some investors refuse to be anything less than majority shareholders, while others are comfortable with minority positions, if they are protected in certain areas. There are numerous methods used to value companies. However, in the end, the share of the pie is usually determined by the relative strength of each party when it gets down to the short strokes, and how badly each side wants to make a deal. Risk assessment can be very subjective, and, if the investor feels the risk is quite high, he is going to try to offset this through a variety of protective covenants, starting with his share of ownership. Aquaculture, in

the eyes of many, remains high risk. Significant up-front capital investment is required. There is no return for several years. Inventory is difficult to assess and, sometimes, control. You're dealing with live creatures subject to disease, weather and natural predators. The market is increasingly competitive and the supply of good business-oriented aquaculture specialists is limited.

The structure of the investment also has to be negotiated. Is the money to be put into the business in the form of debt that requires continual servicing? Again, for aquaculture operations, this could only add to problems of cash flow in the early going. Perhaps conversion privileges could be attached to make it more attractive, or warrants might be given, providing the right to purchase additional common shares at a fixed price for a given period. There are numerous alternatives, but the best rule is to try to keep it as simple as possible.

The all-encompassing shareholders' agreement is another major part of any deal, and sound legal advice is a necessity before signing one. Standard items to be covered under a shareholders' agreement, to protect the minority investor, are the following:

- method of determining salaries for the operating partners;
- limits on capital expenditures;
- control over issuing new shares to prevent dilution;
- monthly financial reporting, including annual audits;
- buy-sell arrangements, including first right of refusal;
- and representation on the board of directors.

Let's get back to basics. It's really people who make the business work, whether it's growing fish or selling hamburgers. All the legal "mumbo jumbo" in the world will not ensure success. It's really the ability and perseverance of management, combined with a little luck, that determines success. There has to be a large degree of trust between the partners, so that when things go wrong, as they always do, solutions are sought, rather

than blame assigned. Taking on a business partner is something like a marriage -- those wedding day smiles can quickly change to frowns and eventual break up, unless there is open communication and trust, and a commitment to making the business work.

In closing, I think the future is particularly bright, although there will be some casualties along the way. I remain concerned over the continuing number of new entrants into Atlantic salmon, when adequate smolt supply remains questionable and market demand and, therefore, price may be weakening. On the other hand, our location gives us a great advantage over Norwegian, Scottish and Irish growers in serving the U.S. market.

To me, the cultured mussel is one of the greatest success stories of all. A few short years ago, who would have thought of ordering mussels in fine restaurants in most major North American cities? One of the disadvantages of my job is that I have to constantly travel, and thus I eat out quite often. Fresh steamed mussels have turned out to be one of the most popular appetizers on the menus of quality dining rooms and restaurants, including this hotel. My personal consumption of mussels has gone from zero five years ago to a least a half dozen meals per month.

Trout is another success story in the fresh form, and I see it growing. Atlantic Ventures is involved in a smoked fish operation in Prince Edward Island, and one of its main product lines is smoked trout which is very popular and used by many of the world's major airlines. Unfortunately, until now, all of this trout has been imported from Idaho. Why couldn't this trout be grown right here in Atlantic Canada? This is a perfect example of an import substitution opportunity and, I hope, it will be pursued before too long.

I am bullish on this industry from an investment point of view. That doesn't mean we should approach aquaculture with a "gold rush" mentality. If the right people, who know what they are doing, are prepared to take advantage of these opportunities, I feel the investment dollars will follow quickly. If aquaculture is the legitimate opportunity for investors that I think it is, it should become a major force in the Atlantic economy in the years to come.

MUSSEL PROCESSING FOR THE MARKET

by
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INTRODUCTION

I will address some of the marketing issues affecting processed mussel products and their potential in the marketplace. We've been working in this area, through T.U.N.S., for the last two years and we feel that we're almost ready to transfer to industry the findings of our research.

I would say Prince Edward Island has really taken the initiative in the processing end. Nova Scotia has not done very much. Newfoundland is making some headway. And New Brunswick is improving also, in terms of production.

What I would like to do is to lean on the mussel survey published by Fisheries and Oceans in 1985. It got a mixed reception in Atlantic Canada. There were a few points that came out which, from our perspective down here, may seen a little contentious in terms of market analysis or the state of the market for mussel products.

MUSSEL SITUATION IN ATLANTIC CANADA

This was really the first attempt, I think, to assess the industry's direction, size and potential growth. If we look at the Canadian situation, what we see is a production level, in 1984, and it's a little higher now, of 1,000 tonnes per year and 68 growers, of which 10 would constitute major Nova Scotia, Prince Edward Island, Newfoundland and New Brunswick operations. Most of the product is going out as fresh mussels, 70 per cent

of it into the food service industry, mostly the white tablecloth restaurants. Only 30 per cent is going to the retailer, fishmonger or fish store.

A supply of somewhere around 50,000 metric tonnes is the level we may be able to maintain in Atlantic Canada. Paul Bredresky from Nova Scotia is estimating that the North American market could absorb somewhere around 100 million pounds (45,000 M Tonnes) of fresh mussels, during the ultimate state of development for the industry. So, you can see, that right now we are at a low level in terms of that potential.

Looking a little more closely at the distribution, we see that, in fact, Nova Scotia produces more mussels than Prince Edward Island. Production in Nova Scotia is around half of the total and Prince Edward Island sits at around 300 tonnes, (but those numbers have slightly shifted now). When the distribution pattern from Atlantic mussels is broken down, you see something like half the product being consumed domestically in the Atlantic provinces, about 34 per cent going to Upper Canada, including the Ontario markets and Montreal, and about 18 per cent going to the United States. So, at least half of our production is consumed locally.

If you look at the potential for expansion, the 1987 estimate is around 3,000 tonnes, worth around $4 million. What we find here is an estimate of 3,300 tonnes for 1988, fairly healthy growth for the industry.

However, when you read through the survey, you see there are a few problems of perception in the marketplace. One of the report's summaries includes the following three points:

1. The present cultivated live product is too expensive in comparison to U.S. imports. Again, when we're talking about U.S. imports, we're talking about bottom cultured mussels, or wild mussels, coming from Maine.

2. Transport systems from the East Coast are too expensive and somewhat unreliable. (I suspect the situation has been remedied since 1985.)

3. Improvements in quality and delivery are needed for effective market acceptance.

Again, I suspect that Atlantic Canada producers might contest some of these points, but it represents a perspective from the other end of the market system.

The survey comments that Atlantic Canada mussels account for a very small component of total market volume, but slightly better than that in terms of market share. This is in comparison to the American counterpart. The key point is that premium products at premium prices put into the marketplace do not meet, in large part, existing market requirements. There seems to be a general preception in all of the surveyed cities, including major cities in the U.S. and Canada, that the quality is comparable between the Canadian product, (longline, high quality mussels), and the U.S. product. Canadian prices are two to three times those of the U.S., however.

Mussels still represents only a small component of the per capita fish consumption per annum in Canada. As we know, health implications indicate that fish consumption will be going up. In fact, in the U.S. and in Canada, consumption of fish and fish products has already gone up this past year by one pound per capita, making it around 17 lb./per capita. Still, mussels represent only a small component.

EUROPEAN SITUATION

When you talk to Europeans, you find that they are the major consumers of mussels, both in the fresh and processed form. A few producers, notably in Ireland, and some in Holland, look at us over here and say, because we use longline culture and our production level is low, that we're not really in a position to get into processing. They would consider production of around 5,000 tonnes a minimum, with bottom cultured or wild mussels as a source. The Irish, for example, tell us that the production costs for bottom cultured mussels in Ireland is about 10 per cent of what it costs to produce by longline culture here in Atlantic Canada.

If you look at the Maine industry, you find that they have basically adopted European growing techniques. Their production costs, in theory, are lower than ours. At the same time, then, they have developed a competitive processed mussel industry, the Great Eastern mussel product being quite well recognized and selling well in the Canadian market at a price around $4.50/lb. Canadian for shucked meat.

As I say, for various reasons, we've been plugging away for the last couple of years trying to promote processing. I think, finally, we're starting to see some interest among small processors. There are people here on the Island and in Newfoundland and Nova Scotia who are now leaning towards processing mussels. What I'd like to do is try to show you where we might fit in.

If you look at some of the European products sold in the North American market, again, the question is not so much the price and the value-added, but how much is selling. And the indication is that there isn't much moving, and it tends to have a fairly long turnover period in the marketplace. Further examples are the Cocosan, a Chile product; the Marina, which is Danish; and the Korean smoked mussel. In this example, there is a difference in labor input. In Korea, they hand-place them in the can and in Denmark, they literally tip them in. So labor rates are a major component.

Also, quality would be a factor. The Korean or Chilean product would be comparable to the Prince Edward Island mussel; the Danish mussel is smaller. So there are a lot of economic considerations before deciding whether to move into processing or to stay out of it.

The Irish frozen product, Tusker Rock, sells well in Europe. Again, there is competition in the European market from Dutch, French, Irish and Spanish production. If we compare the Irish frozen product with products from Prince Edward Island, there is not much difference.

It seems to me that the Europeans are a little bit down on Atlantic Canada. When it comes to processing, the Europeans say it's not really worth it, unless you're involved in bottom culture and have a higher production level than we have at present.

NEW ZEALAND SITUATION

What I'd like to do now is switch over to what I see as a more exciting area and a more positive direction -- the case in New Zealand with the Kiwi Clam or Green Mussel. Although this is a different species, we might be able to learn a few lessons from the way this industry is expanding; it's at the multi-million dollar level. I think it developed during the mid-1970's. These people have been working with a lot of government assistance, mainly because New Zealand is in trouble in terms of export commodities. It lost the lamb market in Europe a decade ago, so it has been coming up with things like the Kiwi clam and Kiwi fruit, trying to win back some of its export drive.

The green-lipped mussel is bigger and I don't think it tastes as good as the product we're producing here. But it's finding a market in the Pacific-rim countries and also on the west coast of the United States. I have also seen this product in Toronto.

New Zealand has developed a code of practice for mussel processing. I'm not saying I'm pro-regulation, but it is trying to standardize its approaches in order to come up with a national identity and a national strategy for processed products. We might be able to learn something from this. New Zealand seems to have a fairly tight organization throughout its processing system, beginning with fresh product.

Briefly, New Zealand has set up along the same lines we have, using suspended culture with all the limitations of the economics of production this suggests. It uses a barrel system instead of styrofoam buoys. It also seems to process on-board to the point where the product can be packed aboard ship for movement in the fresh trade. It has the equipment in place for continuous cooking. I suspect labor rates are comparable to Canadian rates, however. New Zealand produces IQF (Individually Quick-Frozen) products and a range of other products: mussel on a half-shell with its appropriate packaging; and marinated products, with standard preparation techniques and with different labels representing different companies. Again, it wouldn't be too difficult for Atlantic Canada to come up with comparable products in terms of packaging design within the same price range. New Zealand has frozen, shucked meats; smoked meats; marinates and also fresh shucked product in the gallon pail. New Zealand watches the quality of its mussels; it obviously has a good control system in place using this code.

WORLD SITUATION

World production is increasing and has been for some years now. Annual production and consumption is around 400,000 tonnes. So, if we're looking at 1,000 or 1,200 tonnes here in Atlantic Canada, we really represent a very small component of the world market. Breaking that down a little more then, we see that the Netherlands, Spain and France account, by far, for most of the production and consumption of mussel products.

All of this, then, would affect our attitude in terms of moving into processing options for the mussel industry. When I think of all the aquaculture activities in which we have interest in Atlantic Canada, the mussel industry is probably one which is going to be the long-term processing success story. However, you need to get to a certain volume before you can really look seriously at processing. If we analyze the situation right now, we're really small potatoes in terms of gross world production.

ARGUMENTS AGAINST PROCESSING

Right now, then, there are arguments against Atlantic Canada moving into processing. One of those is the fact that we have open and developing markets for fresh product. If the number of 100 million pounds is correct, and we're somewhere around five million pounds, certainly there's no need to look at processing. However, we get into problems with the market because of the decline in product quality during the summer months, the post-spawning condition loss, and also with competition from the cheaper wild or bottom cultured product. Foreign competition, however, is only a problem when you consider the U.S. market.

The other argument against getting into processing right now is the capital investment required. It's very expensive to put in some of this equipment. And mussel shucking and processing equipment tends to take a lot of care, apparently, one factor which is often not evaluated sufficiently. The Europeans are saying that processors try to amortize their equipment over many years, and they tend to estimate the numbers on a longer term than the equipment can acually last.

PROCESSING ADVANTAGES

The potential advantages for processing, as I see them, would be a healthier market in the sense of widening product potential, value-added with raised profit margins and also the issue of using sub-market mussels, something of a problem in Prince Edward Island. A further advantage would be to extend the marketing period. Right now, the market still supports a substandard mussel during the summer months. We might be able to put up a premium quality product throughout the year, and also be able to manipulate the harvesting procedure in Atlantic Canada, standardizing our strategies. The scope for distribution would also be improved in some of the long-range, long-haul markets in the sunbelt. Again, then, when you compare the sub-standard mussel or the sub-market-sized mussel with the market fresh one, there is something of a difference between the two, and we've looked at various options.

FROZEN PRODUCT

Some of the work we've been involved with in the past couple of years has centred on frozen product, and we've now came up with data which would indicate the performance of some of these frozen products against commercially available products from Europe. They provide us with a measure of standardization or reference point. The New Zealand industry did all of this work in 1978 and with their code of recommended practice, all data are available.

We've now got some very good information concerning what will happen to mussels under frozen conditions under various methods of storage. One of the problems with processing is an oxidative rancidity problem, associated with the fat content, which runs around 4 per cent in cultivated mussels. There is a lot of unsaturated fat, mainly in the hepatopancreas component of the mussel, and this oxidizes rapidly when you freeze them.

OTHER PROCESSING PRODUCTS

Experiments with the half-shell mussel show that freezing in brine tends to restrict the development of oxidation rather profoundly (using Degased 3 per cent brine). In that case, we can cut down the rate of oxidation better than if we vacuum-pack. The breaded mussel concept requires a lot of financing to push it into the marketplace, but it probably has some potential. The economics would be another aspect, then, but it would be a way to utilize some of the sub-standard mussels that are now available. Some activity occurring on Prince Edward Island right now, through the P.E.I. Development Agency, might be in terms of taking this up to test market level. We've compared the half-shell against shucked meats, large mussels against small, breaded mussels against small mussels, and brine-frozen, using taste panel facilities. We've also conducted tests on the sensory acceptability following frozen storage. We have a fairly good handle on the performance of these products following various frozen storage regimes. Also, we feel we're in a fairly good position in terms of knowing what's going to happen to the chemistry of these products once they're processed.

CONCLUSION

In overview, Prince Edward Island, and Atlantic Canada in general, is at a point where we can start looking at processed products and, in a sense, monitoring what's been going on in New Zealand. I think the economics will work themselves out. Again, it's a question of the links between the growers, who are tied up, literally, in culturing these products and can move them as fresh, live mussels (the simplest way of handling them), and some of the big food corporations moving in and saying they want to take some of this production and process it to widen the market options for the industry. It's probably a healthy move, whether the time is right at the moment, we don't know; but certainly there has been more interest in the past six months, especially from Newfoundland, Prince Edward Island and Nova Scotia. We anticipate that in the next year or so, you will see considerably more processing activity.

THE AIR TRANSPORT OF LIVE SHELLFISH

by
Al Rach
Manager, Air Canada Terminal
Charlottetown, Prince Edward Island

As most of you know, packaging and shipping seafood has to be done in such a way as to eliminate spoilage; the product is very perishable. We have to maintain a certain degree of temperature control to maintain the quality of the product. We have to get it to its destination in a big hurry.

Basically, one of our main concerns, in terms of shipping fresh fish and shellfish is that it is wet and considered to be "wet cargo". This is mainly because of the possibility of brine spills. As most of you know, brine has a rather dramatic effect on aircraft materials and components; there is a high degree of corrosiveness. When we do get a spill, regardless of size, we usually have to pull an aircraft off the line and it takes us, normally, 24 hours to go through its systems and ensure the aircraft has been totally cleaned up. So, when we look at shipping wet cargo, our concerns are great. This is why it is necessary to carefully package wet commodities; there are specific, detailed instructions contained in our packaging manuals for just this purpose. (See Appendix at end of presentation).

We suggest cartons as containers because they don't weigh too much. This is important because the weight of the carton is calculated into the weight of your total shipment, and you don't want your package to be the most costly thing to ship. It should contain waterproof materials and there are a number of companies now that produce excellent cartons for shipping shellfish and seafood commodities. These should have a leak-proof inner wall, and/or a wax liner. Some wax liners are in the carton itself, as part of the original construction. There are also some with special liners that

fold up, really just a water retainer. Over and above that, you should also use a plastic liner, something like a .09mm liner. It is preferrable that you put it inside your wax liner because claws and mussel shells may cut this plastic. In this way, any spill in the container will be kept within the carton itself. We expect that, in addition, once a shipment travels for 48 hours, the container will also have accumulated a fair bit of moisture from the product itself.

We would also like your mussels or lobsters or whatever, to be put in separate plastic bags before they go into the carton. The plastic should be fairly heavy; again, we recommend .09 mm. If you use a water-tight container for shipping, such as plastic pails, you have to remember that, although they are good, they have to withstand changes in atmospheric pressure due to changes in altitude. They also take a little more room. They are certainly as sturdy as cartons, but you may not be able to carry as much product by volume! They are not very good for live shipments because there is no way the animal can breathe. (In addition, the cost of such containers is higher than wax-lined corrugated boxes.)

Also important, is the size and weight of the individual cartons, because they are stacked, one on top of another, three or even four high. A 45-kilo carton should be able to support 90 kilos, or two more of the same kind of structure on top of itself, in order to maintain the diameter and the content of the compartment we load them into.

Another option to consider is the use of frozen gel packs. A lot of people just use small bags and ice and so forth, but these are very flimsy and easily broken or pierced. So, plastic bags with ice are really not acceptable. I know gel packs are a little more expensive but they are still an almost guaranteed way of keeping your product fresh.

There are styrofoam trays and styrofoam inserts and they are acceptable, but when you are shipping anything in a styrofoam container -- even though you still have to use the plastic liner -- it should be appropriately strapped. We recommend that you do that only when we are using a container-type aircraft or, in other words, when we are shipping air freight on freighters or in our wide-bellied aircraft, so that we can load them into containers, and not on small, ordinary aircraft, like we use out of Charlottetown. Here they get banged around a little more because they are handled more often, and the styrofoam will tend to break. Of course, there are some fiberboard boxes, but I'm not quite sure that they are the answer either. I've seen them around and I think they're probably as inexpensive as cardboard but I do not think that they are as efficient in the long run. As well, they're really not classified as waterproof.

The unit shouldn't be too heavy because it has to be handled by one person. We normally recommend that the weight not exceed 50-60 pounds; an absolute maximum would be 75 pounds. Anything over 75 pounds should go on freighter aircraft where it is loaded in compartments.

Over the past number of years, Air Canada has not been able to carry all the commodity that you want to ship, mainly due to the size of the aircraft and the limited capacity that we have from the Island. However, the advent of the two new airlines, even though they operate small aircraft, (our own connector airline alone will probably be able to handle a couple of extra tonnes a day) will help. We do have a small cooling unit here at the airport in Charlottetown so, if something is delayed, we can keep it reasonably cool and in good quality while waiting to load it. A few years ago, I didn't have such a unit and, if you brought something out, particularly in the summertime, it presented a problem because we couldn't keep it very long. Shellfish and lobsters are good in the sun for about half an hour. So we try to ensure we keep the product under cover and well cooled. And, as I said, we will be able to carry more seafood off the Island for you this year.

APPENDIX

Specific Information taken from "Industry Guide For Acceptance & Packaging Of Fish And Seafood Shipments"

Perishable Cargo - Fresh Fish

WET CARGO: Definition - Shipments containing liquids, or shipments which, by their nature, may produce liquids, such as fresh seafood packed in ice or freezer packs, shall be considered **WET CARGO.**

PURPOSE: To prevent the spillage of any liquids inside the aircraft, because of the danger that spillage or leakage could lead to corrosion or other damage to the aircraft structure or its components. Also to prevent damage to passengers' baggage and other cargo.

PACKAGING MATERIALS:

In selecting packaging materials for shipping of fresh seafood, you must ensure that the material is adequate in material strength and size. It must withstand vibration, shock, stacking, changes in temperature or in atmospheric pressure **WITHOUT LEAKING.**

Following are some typical materials which are used for seafood packaging.

a) Polyethylene Bags and Film

Polyethylene is superior to vinyl chloride in terms of economy, water-tightness and moisture-proof qualities. It also retains its strength under low temperature. One negative factor is that it can be easily torn or damaged with sharp objects. Polyethylene film in any form should be .09mm or more.

b) Styrofoam Trays, Spacers or Boxes

Styrofoam protects the plastic carton liners from punctures, which can be caused from fish bones, fins or shells. An additional benefit, and insurance of freshness of the product, is the further insulating protection provided by the styrofoam box on the market. This type of container allows stacking and each unit interlocks with the box below so that the top box becomes the lid for the lower one. All boxes are then strapped and loaded on skids or wooden pallets. (This type of container or packing method is for freighter aircraft handling only).

c) Corrugated Fiberboard Boxes:

Corrugated fiberboard is a superior packaging material in that it is economical, shock absorbent, easy to process and will not easily tear. It can be used in a wide temperature range. However, it can easily be ruined with water or moisture, and is not categorized as waterproof or water repellent material. Even when cartons are heavily waxed, the fiberboard can break down if same is held in a cooler for any length of time.

Fresh seafood cartons should have a **MINIMUM TOP LOADING CAPABILITY** of not less than 226.8 kilos (500 lbs). The minimum top loading weight must be printed on the carton.

When assembling fiberboard cartons, some care must be exercised so that the metal staples used to close the bottom of the carton will not puncture the inner plastic bag or liners.

d) Refrigerants and Insulation:

Although more a factor of prepackaging rather than packing material design, seafood products must be precooled prior to packing. Insulated containers will retain any heat remaining in the product when it is packed. Freezer or

Gel-Packs will hold the product temperature, but they will not lower the temperature, either at the original packing or while the shipment is in transit. The refrigerant used, should, in combination with the insulation, protect for a minimum of 48 hours. Additional protection must be provided for shipments requiring transfer to connecting carriers, because of the longer transit times, possible exposure to higher temperatures and more frequent handling.

Note: The possibility of adverse weather should be considered in determining the amount of insulation and refrigerant.

A new material on the market, (Cherokee board or Corruguard) combines both cardboard and styrofoam, (a layer of styrofoam sandwiched between two layers of cardboard) and has a high "R" factor (insulating). When a carton is manufactured from this material, it is virtually leak-proof and it requires very little inner refrigerants, (ice/freezer packs). This type of material would also be suitable for either live or cooked lobster as well as shellfish.

e) External Marking and Banding:

Banding and other sealing material should be of a type that does not cut or otherwise damage the container. The type of fish or seafood should be pictured on the outside of the carton, as well as the desired storage temperature. Shellfish cartons should also carry a warning to use extra care in handling. Also, a picture of the contents would assist the cargo handlers in identifying contents. "**THIS SIDE UP**" and "**PERISHABLE**" labels must be prominently printed on or attached to at least two outside vertical walls of each container or carton. This is particularly important in keeping shellfish alive and in good condition. Each box, carton or container must have the complete address and contact information, including the telephone number of the consignee.

Following are some of Air Canada's container requirements:

a) Containers must be leakproof.

b) Outer containers constructed of fiberboard should be wax impregnated. Folded corners are strongly recommended whenever container shape permits. The objective of such packaging is to provide additional protection against leakage and to prevent carton material from exposure to external moisture. The carton cover should be of telescopic design.

c) The container should be of a size and weight for convenient handling. Weight range for containers which can be handled by an individual is between 9.1 kilos (20 lb.) and 34.0 kilos (75 lb.). Containers of 34.4 kilos (76 lb.) or over will be forwarded on freighter aircraft only. If a shipment is consigned to a destination not served by freighter aircraft, it will be refused.

d) The product must be placed inside .09mm polyethylene bags which can either be heat sealed or tied with elastic bands. To prevent the bag from being punctured by fish bones or shells, it may be necessary to use protective pads or styrofoam or crumpled newspaper.

e) Gel-Packs are the **RECOMMENDED** refrigerant for fresh fish (seafood) as well as shellfish. Crushed ice will only be accepted if it is placed in double plastic bags of .09mm polyethylene. Both bags are to be sealed with elastic bands.

Note: For live shellfish, the bags must be left open, but the outer container must have "**THIS SIDE UP**" labels.

f) Shipments found to be leaking on receipt at the Air Canada cargo terminal will be refused. Also, where a shipment in transit is discovered to be leaking, same will be removed from the aircraft and turned over to the cargo department for disposal.

g) A record will be kept of all liquid spills occuring in Air Canada aircraft. The cargo office originating the shipment will be advised and in turn they will contact the shipper and review his packing methods. If a shipper refuses to change packaging in future shipments, his traffic may be refused.

THE MARKETING OF FRESH PRODUCT

PANEL

SPEAKER	AFFILIATION
Mr. Robert Robillard	Waldman's Fish Company
Mr. Ivan Kerry	P.E.I. Development Agency
Mr. Peter Darnell	Indian Point Marine Farms
Mr. Russel Dockendorff, Jr.	St. Peter's Bay Mussel Farms Inc.
Mr. David Walsh	Atlantic Ocean Farms

Russel Dockendorff, Jr.
St. Peter's Bay Mussel Farms Inc.
St. Peter's Bay, P.E.I.

We started a mussel company about seven years ago, St. Peter's Bay Mussel Farm. It's a family-owned company begun by my father, my brother, who is not on the Island now, and myself.

In 1979, we were not yet into serious production. We simply had enough mussels to supply the deep-freeze. But we could see that it was a developing industry and one that would soon become a money-producer. The company was incorporated in 1982. At that time, we had to move to a processing line simply because there were no processors in business here. There are now, of course, two on P.E.I. Processing for the live market seemed like a natural extension of the industry in 1982. And now, processing beyond the fresh market is an important consideration. But from 1982 to the present, the fresh market has held the attention of the industry, and will probably continue to do so for some time to come.

Speaking as a processor, you cannot sell a product you do not have. The first thing that we had to develop was a product, then the ability to process the product for the fresh market and, eventually, we had to learn to market it.

We have to guarantee two things: the quality of the product and its reliability.

At present, growers on the Island who have come onto the scene at a later date, no longer have to process and market their own product. They can sell to a processing company, which then markets the product off-Island.

In 1982, we started marketing. It was an extremely large step for a family-owned and operated business. We had started with a background in the fishing industry. I mention this because, whatever a mussel grower's position, whether potential grower or new grower, you can always start small and develop later. If you have a background that supports or brings in other income, then it will be very beneficial because you will be able to support your mussel-growing endeavors with that income but also, through the financial help of relatives and friends.

I would credit the success of our marketing effort to two things. First, we owe the success of marketing to people like Ivan Kerry (P.E.I. Development Agency). The government was extremely helpful in the early stages. It continues to help in expanding the industry, and Ivan Kerry remains a great supporter. So initially, it was the government which assisted the mussel industry in developing markets. Secondly, we established markets ourselves through personal contact, telephone contact and, then, through the quality of the product. The news got around by word of mouth.

Our company, St. Peter's Bay Mussel Farms, is successfully growing, processing and marketing its own product. The potential remains in Atlantic Canada for other such privately-owned groups to start and take an operation through the very same stages to create a similar success.

Ivan Kerry
Promotion of "Island Blue Mussel"
P.E.I. Development Agency

Marketing is not very difficult when you have the best product in the world. My job with the P.E.I. Development Agency was to promote all Island products, including agriculture, fisheries, and manufacturing. With mussels such a new product, I found it very interesting and I spent a little more of my time with the mussel industry than with other parts of my job. I say it's the best product in the world. I have a letter from a man in Europe who sells mussel machinery internationally and he states that Prince Edward Island mussels are the best. I believe that.

We registered the name, "Island Blue Mussels" and we expect all cultured mussels leaving the Island to be shipped under that name. The concept worked well for Malpeque oysters, and we think it's working well for mussels.

I don't think we should be using the small-sized mussel as some kind of a garbage product, because there are many people who prefer a smaller mussel. I think we should be selling them as "Baby Blue Mussels"

Our research technicians have done some work on additional mussel products. However, I don't foresee selling many of them for a long time. There are millions of people in North America who have not yet tasted a mussel. In every place I demonstrate mussels, even here in Prince Edward Island, there are many people who are tasting them for the first time.

Mussels are very delicate and delectable, and they should be handled and stored with extreme care. I have seen mussels that have only been out of the water for a few days and, for some reason, they are close to dead. I was in a large supermarket in Moncton one day, and someone who knew a lot about mussels was at the seafood counter. He said that the mussels there

were dead. The person working at the counter saw me there and called me over. I said that they couldn't possibly be dead because they had just arrived. They had come out of the water only two or three days earlier, and to prove they weren't dead, I ate one raw. So the man figured he was wrong and left, but that mussel was very strong to the taste. The next day a thousand pounds of fresher mussels arrived and I ate one (raw) to see the difference, and it was perfect. So, even though those first mussels hadn't been out of the water very long, there was something wrong with them. That "something" you producers and processors are going to have to figure out.

I demonstrated mussels in seven large supermarkets in the United States in June, when I don't think mussels are of the best quality. But the buyer was determined that we come and demonstrate them. I cooked mussels and passed them out, a couple at a time, with the packaged mussels right beside me. We sold them for $1.49 a dozen, not a pound. In the bars in that city, they were selling for $2.50 a dozen, steamed. So don't let anybody tell you that Atlantic mussels have to be sold as a garbage-type product. They can be sold very profitably. We sold 5,000 pounds in four days in that city. I don't like to see anyone cut prices, because once you get the price down, you can't easily get it back up.

When I demonstrate in supermarkets, people ask me how to cook mussels. I tell them to put them in a covered pot, turn the heat up, and when the steam lifts the top, they're ready to eat. I don't put anything on mussels when I'm demonstrating them in these markets or seafood shows. They should not be doctored up, even with garlic. And I tell people to drink the wine when they are eating mussels. In Los Angeles, at the seafood show, people came around and ate our mussels. They said they'd eaten them at 10 or 12 different booths, but none could compare to ours. It wasn't the mussel itself that was the problem; some tables had an assortment of sauces, and you wouldn't know whether you were eating mussels or codfish after the sauce goes on.

You should be selling mussels by the count or by the mussel, not by the pound. Restaurants start asking what they cost and I tell them seven or eight cents apiece. If you put 12 or 15 on a plate, you can charge $4.95, $5.95, $6.95, or $7.95, depending on how many white tableclothes you have. They can figure that out very quickly.

I was on Long Island last March at a restaurant food and beverage show. They couldn't get over how you could take mussels out of the box they were shipped in, put them in the pot and cook them. The mussels they were accustomed to required someone in the kitchen to brush and scrub them, and cut the barnacles off. When you tell them what they are worth apiece, and they know exactly how many they are going to serve, they know what they are worth to them and they will pay real money for them.

One restauranteur in Boston told me he'd pay $3.50 a pound. I didn't know what the distributor would take, so I said that they might get up to $3.50. He asked how many mussels in a pound and I said there were 25 to 30, so he paid $3.50 a pound for them. You have to charge enough so that the people who are working out on the ice in the winter can get a decent paycheque on Saturday night. Also, let your customers know that they have to pay every seven days, and that your fishermen have to be paid every Saturday night. Don't let your accounts go long because some fish buyers are inclined to let their accounts go if you don't push them.

There's all kinds of markets out there that haven't yet even been touched. Go after them.

Robert Robillard
Waldman's Fish Company
Montreal, Quebec

Mussels were introduced to Morris Waldman in 1950/51 by Emile Albert of Nequac, New Brunswick. Mr. Waldman took a few hundred pounds for bulk in-store display, inviting customers to pick their own. Price? $0.29/lb for retail and $0.25/lb to restaurants and hotels.

Today, 37 years later, Waldman displays a huge mound of fresh mussels at retail counters, and customers still pick their own. Price? $0.39/lb among our most famous mussel pickers cum connoisseurs, former premiers, cabinet ministers, radio, TV and stage personalities.

Waldman now sells approximately 12 to 15,000 lb. of various mussels weekly, depending, of course, whether there is a special holiday, such as Christmas, Easter, or possibly even Mother's Day, when sales soar.

The first cultivated mussels originated from the state of Maine. They were not, of course, true cultivated mussels, but, rather, selected for size, cleaned and re-packed, thus improving on the wild mussel and bringing in a slightly higher price.

Restaurants and hotels were quick to respond to the improved product, while Waldman stuck to the wild variety for its retail market, so as to keep the price at its lowest level and to, thus, maintain sales volume.

In recent years, P.E.I. has successfully introduced its real cultivated mussels. Better restaurants and hotels have become faithful customers.

Why is that? The answer is quality, consistency and honesty. Those growers who have elected to maintain and improve on their product have progressed in the market. The shady packers who were only there for the ride have fallen off or were dropped off by buyers.

More recently, still, the Magdalen Islands have introduced to the marketplace Quebec's first cultivated mussels. In 1985, only a few thousand pounds were shipped. In 1986 several more thousand pounds came to the market, and with a boost from TV and newspaper interviews and promotional articles, sales went quite well, given the relatively short time that they were available. This coming fall, when they are again harvested, the supply will probably be larger and, thus, will find better acceptance by the restaurant trade. Their immediate acceptance was certainly due to alert and forceful publicity which built up their image and created instant demand.

CURRENT MARKET/ SUPPLY SOURCES/ MARKET TRENDS

Given the approximate volume of weekly mussel sales at Waldman's, one might wonder about the ratio of sales of one type or the other. So here's an idea, based on a potential week of 15,000 pounds:

Cultivated mussels -- approx. 45 to 55 per cent
Wild mussels -- approx. 35 to 40 per cent
Selected mussels -- approx. 15 to 20 per cent

These figures show quite well, I think, the impact that the cultivated mussels have had on Waldman's restaurant and hotel trade. The wild mussels maintain their position with the public at large. Our retail customers just prefer to pick their own from the mounds of mussels on display. As for the so-called selected mussels, their declining position is due in good part to the increasing favor cultivated mussels find with the restaurant trade.

PROVIGO AND THE FUTURE OF CULTIVATED MUSSELS IN QUEBEC

Provigo acquired Waldman's Fish Co. in early 1980. Earlier this year, Provigo acquired another fish and seafood wholesaler, which had been established in Quebec City for 25 years or more with a sales branch in Montreal that opened about three years ago. Now, we're talking about the kind of potential volume for Pêcheries St. Laurent that would make it the biggest in Quebec.

I cannot speak of sales volume for mussels, but I do know that their distribution system and their penetration into the restaurant trade are second to none in Quebec City.

Let us especially not forget that Provigo is a supermarket chainstore operation, with approximately 200 stores throughout Quebec, the largest of which already has a specialty fish service counter. Also more are to become so equipped as time goes on -- and Waldman's will certainly be called upon to service them.

PROMOTION

In light of the above, what's the mussel grower to do?

Will he do what so many oyster shippers before him have done? That is lean back and gloat over a job well done because customers came to him and wanted more product than he could supply? He, of course, would promptly sacrifice quality and raise his prices. Those of you that are my age remember what effect that attitude had on this area's reputation for conscientious businessmen.

By all means do be proud of a job well done, because you have done a good job. But does the market at large know that you, the mussel grower, exists? How far have you reached in your recent promotional efforts? Have you had press releases, press conferences, or, maybe, arranged to be interviewed by CBC's Country Canada or La Semaine Verte in French? I'm quite sure you know someone who knows someone who can arrange it for you. Have you had banners or posters, and menu clip-ons printed? These are handy tools for the wholesaler to use to help you promote your product. Do the federal and provincial governments have informative bilingual booklets about you and your products? These are always welcome at a retail fish counter. Ms Housewife 1987 is more seafood-oriented than her mother before her, so tell her you exist.

Do not expect your wholesale customer to do a perfect job of promoting for you. He can't. He hasn't the time or the resources.

Peter Darnell
Indian Point Marine Farms
Mahone Bay, Nova Scotia

I will discuss the approaches we have taken to marketing fresh mussels, the problems we have encountered, the solutions we have found and the solutions we are still seeking.

Our farm in Mahone Bay, Nova Scotia, is only a one-hour drive from a reasonably large market, Halifax, and only 90 minutes from an international airport with direct flights to the rest of Canada.

When our first crop was ready for market, we arranged to sell most of it through a fish wholesaler-retailer in Halifax. We made and continue to make twice-weekly trips to Halifax to supply him. At our end, we have converted an old store, which is right on the water, into a DFO-licensed shellfish plant, approved for export. In it, we have a CMP declumper/grader, pumps, inspection conveyors and small tank-holding facilities. In order to supply our Halifax broker, all we have to do is take the mussels in 100-pound tote boxes directly from the inspection conveyor to our truck and then to Halifax, where they are drained, weighed and transferred to the buyers' boxes. No fuss, no muss, and cash on the barrelhead. We can harvest in the morning and be rid of them by mid-afternoon. We relinquish responsibility for the mussels after delivery and do not have to be involved with the myriad problems of wholesaling and retailing them. We do not have to be involved with packaging expenses, delinquent accounts, buyers who are only a voice on the telephone, or airline and truck schedules.

Since we have been able to produce a larger crop each year, our broker has been able to increase sales commensurately, mostly in the local market, with some sales to the rest of Canada. Of course, along the way, we have tested the waters by exporting, ourselves, to brokers in other cities. We have done this because we were attracted by the apparently better prices we could receive for our mussels in this way, but we have found that the export business is not quite as easy as it seems.

First, we had to buy cardboard boxes which Air Canada would approve -- a waxed box with a waxed liner -- with the company logo, product, weight, etc. printed on the outside. Now, if a particular customer wants mussels shipped in 30-pound lots -- a smaller than normal box -- the price for packaging is in the vicinity of 10 cents per pound. This can be reduced with a larger volume purchase of packaging, however. Next, there is the normal practice of including an extra 10 per cent of product by weight because of shrinkage due to water loss. The cost of phone calls to Edmonton is a lot more than calls to Halifax. If Air Canada makes mistakes handling the mussels, it's our problem, not the customers. Finally, the money comes 30 days later, if we are lucky.

Suddenly, that export price is not as attractive as it first appeared, and now there are fewer hours in the day for mussel production than there were before because of the extra work shipping entails. A further disadvantage when we ship ourselves is that we only have one product and, to gain favorable freight rates, we have to move an airline container full of mussels at one time (approx. 2,000 pounds), while our local broker may ship 500 pounds along with, for example, cod fillets and lobsters. After all, most of the export customers are buying more than just mussels, so they are better served this way.

The disadvantage of dealing with a local broker is that the price he can offer in an increasingly competitive market may not be favorable compared to a large mussel shipping organization. The local broker represents an extra middle man in the chain between grower and consumer. Also, he may not be as committed as you would like to maintaining quality. For example, he may ship mussels to Toronto that he has refrigerated for a couple of days. This may be acceptable practice with mussels for a local restaurant, but not to distant brokers who may then hold them for an extra few days before they are sold.

For the local broker, mussels are just another product among the many he carries. If mussels are not moving well, he can cover by selling more of something else. He may not necessarily get on the phone and move them like you would want him to do.

Individual growers, marketing on their own, also face other disadvantages in the marketplace. Sometimes, due to circumstances beyond our control, we must break the cardinal rule of the seafood business -- providing continuous supply. Factors such as ice, or unexpected slow growth, or unexpectedly brisk demand are reasons for this. Also, because demand remains high, we are forced to sell when the mussels are out of condition. A co-operative marketing venture could maintain a constant supply through these critical periods.

As we all know, marketing is the bottom line in aquaculture, and I know that our company, along with many others in Nova Scotia, is arriving at the point at which we must get our act together in order to get greater volumes to more distant markets.

David Walsh
Atlantic Ocean Farms
St. John's, Newfoundland

Atlantic Ocean Farms is a private corporation, like the Dockendorff organization, (St. Peter's Bay Mussel Farms), which grows, processes, and markets its own mussels. To this point, we supply our local markets in Newfoundland and cater to some of the supermarket chains' fish counters in several of the larger centres. Because of the volumes we've produced to date, we haven't had an opportunity to go any further than that.

As our volumes are increasing this year, we are launching a secondary processed item to come on the market within the next couple of months and to be distributed throughout the Maritimes. It's a mussel salad. To produce it, we are utilizing our undersized mussels, instead of wasting them.

Now that we have the capability to automatically take the meats out of the shell, we can do all kinds of new things. In Newfoundland, in particular, where there are a number of well-developed processing facilities that have a lot of infrastructure and equipment, there's potential to work with them to do a number of different items. You can go as far as your creativity will take you.

I guess Newfoundland has certain unique problems. Its distance from the market is greater than for P.E.I., Nova Scotia and New Brunswick so shipping fresh product to Montreal, at this time, for us, cannot be done by truck due to uncertainties in the weather and ferry crossings. We have to ship by air and that's more expensive, involves more handling, and more elaborate packaging. However, we make up for these disadvantages in other areas. Our growing techniques are probably a little less costly, for example, than they are in the Maritimes. We have to balance one against the other in order to compete in the marketplace.

We pack mussels in a clear kilo bag. There are cooking instructions on the bag, both in French and English, along with recipe ideas. They sit right at the fish counters on ice and people can simply pick up the bag and go. Many of the supermarket counters liked this presentation. I see Newfoundland's level of production increasing during the next few years. From all indications, the markets seem quite good.

One problem we have experienced in the marketplace in dealing with supermarkets is that a lot of their seafood counters are new, and the people who are setting them up and running them are not necessarily well-trained. We've had letters from customers and, I must say, I certainly appreciate those letters because they give you feedback on your product.

However, I received one letter from Northern Ontario and this gentleman had travelled the world. He said he had eaten mussels in just about every country and he had never tasted any as bad as ours. I looked at the date on his letter and it was November. We had shipped mussels to this particular supermarket in June! I promptly wrote him to discover that the supermarket had put the mussels in the freezer. So, of course, when he bought them and cooked them up, they'd been six months in the freezer and they hadn't been pre-cooked before they were frozen. So, when they were finally cooked, they all stuck to the inside of the shell. I suggested he go back and talk to the store-owner, and we informed our broker about the situation and he checked it, as well. It's clearly marked on the bag, "Keep Live Product Cool", but someone had put them in the freezer without thinking about it. This is the kind of thing you run into sometimes.

Another person wrote us that our mussels were gaping a bit. She thought they were dead, so she threw them away. Again, I wrote back and asked if she had read the instructions on the bag and she said that she hadn't. In the instructions, it says "pinch the mussel several times and it will close". It further suggests "taking the package from hot to cold or vice versa will tend to make the mussels gape". She wrote back saying that

she hadn't done so, but said that the ones she had picked out tasted delicious, and she would go back and buy the product again when she saw it in the supermarket.

So it's good to get feedback because it brings out the problems that can develop along the distribution chain, but you have to be prepared to deal with them. I think that's very important when it comes to marketing. It requires a very large effort. It's very expensive and, if you are marketing your product, it's a big commitment. You have to follow up on your product and make sure that it's being serviced properly and promoted. Promotions and in-store demonstrations, as Ivan Kerry mentioned, work well. We did one at a new Sobey's store in St. John's, and the CBC's Land and Sea did a documentary on our farming operation. As a result, our sales have just skyrocketed. Promotion and publicity really do work.

PANEL
DISCUSSION PERIOD
on
THE MARKETING OF FRESH PRODUCT

The following points were raised during the discussion period which followed the presentations on marketing of fresh product:

- debyssed vs. undebyssed mussels;
- public education;
- problems in the distribution network;
- processing and marketing secondary products.

DEBYSSED VS. UNDEBYSSED MUSSELS:

It was generally agreed by presenters and participants alike that although the undebyssed mussel had a slightly longer shelf-life, the debyssed mussel, which is much easier for the consumer to handle, is a much better product for the market. It was agreed that the slightly shortened shelf-life presented no problems.

PUBLIC EDUCATION:

It was agreed that the public must be better-educated with respect to the mussel, particularly to the fact that gaping mussels are not necessarily dead. The same concern regarding education would hold true, of course, for all fish handling and preparation procedures.

PROBLEMS IN THE DISTRIBUTION NETWORK:

Concerning the distribution network, it was pointed out that everyone dealing with fish products must have the necessary equipment, e.g. ice machines, and must follow correct shipping techniques, including icing and refrigeration. Information exchanged at the Workshop should provide a needed boost in this regard.

PROCESSING AND MARKETING SECONDARY PRODUCTS:

The final point raised during this panel discussion was the market for fresh mussel product. No open-ended fresh market exists. It is important to start developing processing schemes and a secondary products market because they may be needed in the future. It takes a lot of time and effort to get something of that scale underway. It was pointed out that Newfoundland and Prince Edward Island have begun to lead the way.

RAPPORTAGE

MUSSEL CULTURE

by

Maurice Mallet

Considerable emphasis was placed during the mussel culture sessions on three major areas of concern to growers:

- carrying capacity per leased acre/hectare;
- post-spawning mortality; and
- a monitoring program for growers.

Carrying Capacity - In some areas in Atlantic Canada, 75-80 per cent of the area suitable for mussel culture is already committed. Over-crowding could become a problem; carrying capacity will dictate future productivity increases under such circumstances. Biologists and technologists within the department and with research institutes should do more to explore this potential problem. An educational program for growers should be used to dispense that information.

Mortality - Rates as high as 25-50 per cent have been observed in certain parts of Atlantic Canada, seriously impeding economic viability within the sector. Research has been sporadic and unco-ordinated to date; growers are experiencing difficulty in obtaining information. It was suggested that, by way of response, a responsibility centre, supported by an operational data base, be established in the region.

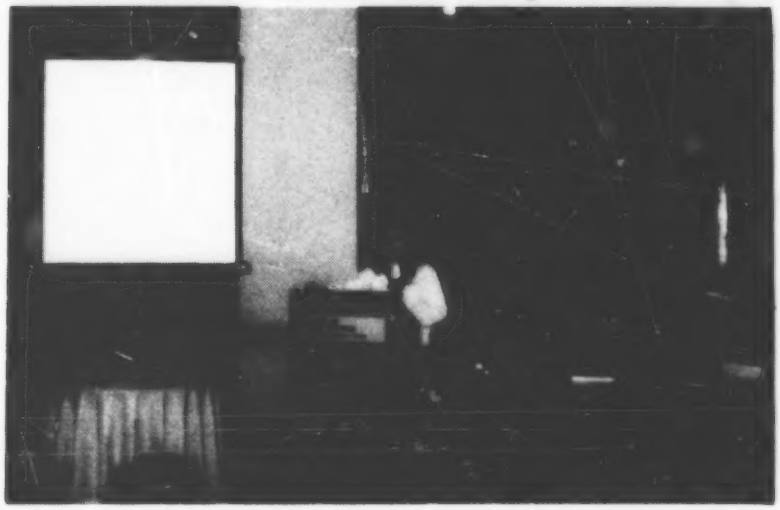
Monitoring Program - Productivity is often the result of environmental factors, of which growers have insufficient knowledge and over which they have inadequate control. There are many unanswered questions in this regard. The issue is whether government, the research institutes or the growers themselves must provide the answers. The consensus seemed to be that it is a grower responsibility, but that they must be helped through the provision of an environment monitoring program. Such a program would help them monitor environmental indicators and modify their individual operations accordingly. Such a program was deemed feasible and an investment in the order of $1,500 per site would be required to provide growers the necessary technical capability.

Other topics of discussion centred on marketing problems (misrepresentation of wild mussels as cultured); the need to streamline leasing procedures; the shortage of quality seed; possible diversification into other species (scallops, quahaugs, etc.); and the potential for secondary-level product development -- all with obvious implications for the Department of Fisheries and Oceans.

SECTION II

OYSTER CULTURE

Oyster culturists also heard a number of presentations by experts in the field. Two are shown here, (above) Jim Jenkins, Chief, Resource Allocation, DFO, Charlottetown and (below) Dr. Catherine Enright of the National Research Council's Atlantic Research Laboratory in Dartmouth, Nova Scotia.



THE ATLANTIC OYSTER INDUSTRY - A PRECIS

by
Jim Jenkins
Chief, Resource Allocation
Department of Fisheries and Oceans
Charlottetown, Prince Edward Island

I will begin by giving a brief overview of the production figures in order to illustrate the relative value of the oyster industry in the Atlantic provinces during the past 15 years, (Table I).

Over the years, Nova Scotia hasn't had a large quantity of oysters, but what it has had has been very important to the people involved in the industry. Just because Nova Scotia produces small quantities, should not be interpreted to mean that it isn't an important part of the oyster fishery.

In New Brunswick, production has been erratic, as it has been in P.E.I. New Brunswick produces in the range of 800,000 to 900,000 lb./yr., mostly along the estuaries, and particularly on the Gulf coast. There's virtually no oyster fishery, however, in the Bay of Fundy and, in Nova Scotia, there's no fishery on the Atlantic coast.

On P.E.I., we're blessed with quite a few rivers and inlets, (in particular, Bedeque Bay in Summerside, the East River area in Charlottetown and the West River area). Production in P.E.I. hovered between one and two million pounds in the 1970's and there has been a gradual increase since then to the point where we now produce 3.4 million pounds.

TABLE I

OUTPUT OF OYSTERS LANDED IN MARITIME PROVINCES, 1970 - 1985

Year	Quantity (pounds)		
	Nova Scotia	New Brunswick	P.E.I.
1971	40,600	463,000	1,810,700
1972	61,200	639,000	993,700
1973	56,800	695,500	1,301,900
1974	46,100	932,900	1,333,700
1975	35,800	1,439,900	1,612,800
1976	113,400	871,800	1,558,800
1977	119,700	753,800	1,847,800
1978	142,000	848,700	2,318,900
1979	157,545	793,000	2,484,900
1980	189,630	787,185	2,361,707
1981	224,910	555,660	2,686,275
1982	108,045	833,490	1,917,585
1983	123,480	882,000	2,434,185
1984	189,630	1,583,190	3,385,318
1985	44,100	923,895	3,403,240

How important is this industry to fishermen in these areas? Consider that an average price for shellfish (landed value) is approximately $0.70 per pound. You can see, then, that the oyster fishery on Prince Edward Island, for example, is worth more than $2 million. If you're talking about the lobster industry, that's relatively insignificant, but, if you're talking about $2 million shared among the 1,500 oyster licensees we have on P.E.I., you can see that it's a relatively important fishery for our

commercial fishermen. Similarly, in New Brunswick and Nova Scotia, this fishery is important to those individuals who participate.

Oysters on P.E.I. generally run second or third in importance behind lobster and Irish moss. What we have here is a very important fishery which provides income to commercial fishermen who are usually in the lower-income category. I must emphasize, therefore, that this fishery is extremely important to such people. It must be built upon and enhanced.

The main oyster-producing areas are concentrated on the Gulf, particularly, the southern Gulf (Figure 1). There have, in the past, been several attempts to introduce oysters into Newfoundland, each one unsuccessful. On P.E.I., the Charlottetown area and the Summerside-Bedeque Bay area are public fishery areas which are very important. There is also a public fishery in Cascumpec Bay. Along the coast and along Northumberland Strait, a number of estuaries and bays provide an important supply of oysters.

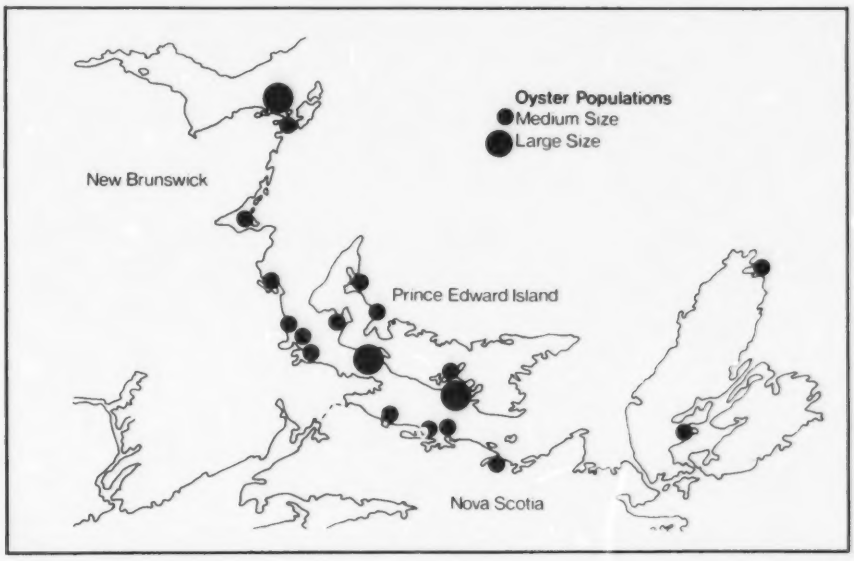


Figure 1. Principal oyster-producing areas of the Maritime Provinces

Along with the public areas, we also have many leased areas. On P.E.I., leased areas are extensive. There are also leased areas all along the coast of New Brunswick and scattered along the Gulf shore of Nova Scotia (particularly in the Bras D'Or Lake area). These are private leases, leases which are owned by individuals or companies. The area leased out is quite extensive. A large number of them are not utilized, or are used very little.

The oyster fishery in Eastern Canada is mainly directed to the half-shell trade. The oysters are shipped to Quebec and Ontario and, as well, to the Eastern Seaboard of the United States. Some people even fly them to the west coast of the United States, although this is done on a rather small scale.

The grading system we use for oysters is based primarily on shape and size. There are fancy, choice, standard (a more elongated oyster with a less appealing shape than the others), and the commercial or sub-standard oyster (it doesn't fit into any of the previous categories, and is sometimes misshapen).

During the 1800's, we established quite a fishery here in the Atlantic provinces. It declined dramatically in the early 1900's, and we have to ask ourselves why? There were two basic reasons: 1.) overfishing and 2.) Malpeque disease. The first speaks for itself; the second, perhaps, needs some explanation.

Malpeque disease first developed in the Malpeque and Cascumpec Bay areas of P.E.I. between 1920 and 1950. It spread around the North Shore and also went across the Island to the south coast around 1935-40. For a time, the disease was relatively well-contained on Prince Edward Island but it is suspected that someone transferred oysters, which were diseased, from P.E.I. to New Brunswick in the early 1950's. It then spread to the north from there, and then down along the New Brunswick-Nova Scotia border, wiping out the oysters as it went. It was also found in the Bras D'Or Lakes in 1955.

It wiped out 90-95 per cent of all oyster populations. Those oysters which remained, however, were disease-resistant, and they became the stock that we use today to enhance our oyster beds and to stock our leases. We're very fortunate to have oysters which are disease-resistant. The United States, for example, has not been so lucky with MSX disease.

We have two basic types of oyster fishery in Atlantic Canada. One is the lease fishery and the other is the public fishery.

How do we stock a leased fishery? One of the methods is to buy or fish oysters from the public fishery. In the oyster industry, people fish oysters with tongs, using dories (shown in the photo below).

Fishing oysters (using tongs) from a dory

There are cleaning boards on both sides of the bow. The advantage is that when the fisherman puts his tongs over, he doesn't just pick up oysters, he also takes up oyster shell and other debris. The debris he does not want, such as oyster shells, is thrown back overboard. This provides a chance for that oyster shell to remain on the surface of the bottom (bed) where it can collect young oyster when they are ready to set. Every time the fisherman takes a tong of oysters or debris from the bottom, he is actually cleaning the grounds as he goes and he's providing new surface for the oysters to set upon. In addition, of course, he's gathering oysters to make money.

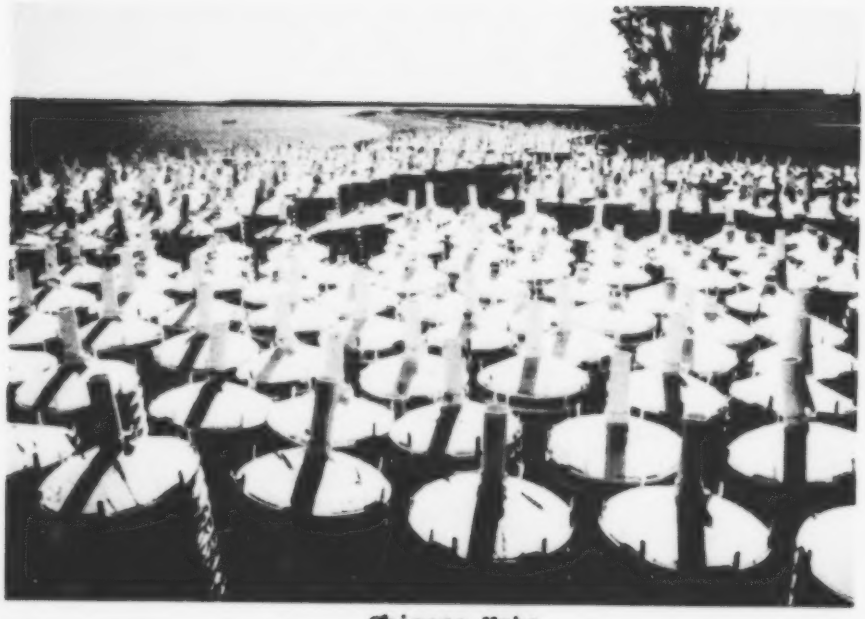
The public fishery occurs mainly in the spring. The season here (May 1 to July 15) is restricted to contaminated areas. The idea is to harvest the oysters at that time, relay them to clean ground, and market them at a later date, (after August 15).

In addition, we have what we call an open-water fishery, which runs from September 15 to November 30. In our experience, the spring fishery is much more beneficial to the industry than the fall fishery. We have found that the fall fishery areas usually show a decline in catch rates. We suspect that, in the fall, you may indeed take up extra shell and debris but, over the winter, it resilts and doesn't provide a good surface to collect young oysters the following year. The spring fishery, on the other hand, does. It provides a good surface to collect oysters for the following year.

How else can we enhance our leased fishery? We also utilize a cultch. A cultch is oyster shell -- fossil oyster shell, simply old, dead oyster shell hauled up from old beds on which they accumulated over a number of years. They're either spread loose on the leased area to catch spat, as shown in the next photo or they're put into mesh bags, similar to those our colleagues in the mussel industry use. These are hung from ropes (fences) in the stream.

The spreading of fossil oyster shell (cultch) over a leased area (above)

Another method commonly used, with particular interest being shown in New Brunswick, is the Chinese hat. We've used Chinese hats since the 1960's. They are conical-shaped plastic cones placed on a plastic bar, covered with a cement coating, and hung. The spat sets on them; the cement coating is broken off; and the oysters are then individual. We have moved away from the Chinese hats on Prince Edward Island. They are expensive to purchase and we found them very labor-intensive. They were not very cost-effective. The oyster producer can't afford to purchase such items or to finance the labor required to make them work properly.



Chinese Hats

A fourth method is the veneer ring. The veneer ring is a thin strip of wet wood, twisted into a circle and stapled. This is then coated with a thin layer of concrete. The concrete is a mixture of cement, sand and lime. It is allowed to harden, and is then set out at the appropriate time. One very important point when you're using this type of apparatus is that the cement coating will kill larvae if it's not leached out, prior to use.

On P.E.I., we have found that a large number of the leases are not producing. More than 80 per cent of our leases are not being utilized. Of the remainder, 15 per cent are only partially utilized and only 5 per cent of leases in oyster-producing areas are producing at a reasonable rate. Even this last 5 per cent is not producing at maximum levels of output.

As I mentioned, our leases are not very productive, and we find that approximately 85-90 per cent of P.E.I. oysters originate on public beds. In Nova Scotia, I understand, the public fishery is not as large and most of its production, even though it's somewhat smaller than ours, originates on private leases.

But, given that we have our public fishery, and it involves increasing numbers of fishermen, how do we enhance it? How do we get it to grow? Is the fishery important enough for us to put effort into it to make it expand? I might mention to you that on Prince Edward Island, for example, our catch rate in 1985 was only 30 per cent of the peak landings in the 1800's. New Brunswick is only producing at 20 per cent of its peak landings, so we know we can increase at least five-fold. Unfortunately, Nova Scotia is now fishing at approximately 5 per cent of the peak rate and breaks the pattern.

In enhancing the public fishery, the methods we use are not unlike those already described and include relocation. What we do is harvest the oysters in shallow water areas that would suffer winter kill by the ice, and we relay them into deeper-water areas. How effective can that be? In Cascumpec Bay, we moved approximately 5,000 five-peck boxes over a period of three to four weeks and, in Bedeque Bay, we moved 3,500 boxes from shallow-water areas to deep-water areas.

Another method is to spread fossilized shell over the bottom, evenly distributed, and this collects oysters during setting time. (This method is also used extensively in the Eastern United States). Old oysters, therefore, are used to collect young oysters, rejuvenate the beds and make them productive into the future.

Other methods are used for both the public and private fisheries and include shell bags, veneer rings and Chinese hats. We also use de-silting rags which flip up oyster shells that have been put on the bottom, thus removing the silt to provide clean shells for the spat to set on.

We have predators such as starfish, but we usually control them with quicklime. Another problem is mussel beds migrating into and over oyster areas, a particularly difficult problem in warm estuaries and bays in the southern Gulf. Eelgrass may choke out the beds and make it difficult to fish and another type of seaweed, sea lettuce or Ulva, can also choke out a bed. Other problems include contamination, siltation, and competition for use of our waterways. More and more people are using the water for recreation purposes, mussel growing, and trout farming. And agricultural practices in the southern Gulf area of New Brunswick, P.E.I. and Nova Scotia, creates a lot of run-off. All of this activity can also affect our beds and make them less productive than they might be.

THE PRIVATE OYSTER INDUSTRY IN NEW BRUNSWICK

by
Ernest Ferguson
Development and Resource Allocation
Fisheries and Oceans
Tracadie, New Brunswick

Introduction

In 1985, oyster landings by the private sector in New Brunswick totalled 314 metric tonnes. This sector involves 842 leaseholders having 4,080 acres under lease in 18 inlets throughout the eastern part of the province. Its production potential, however, is 8,000 tonnes, with multiple plantings. The major obstacle to the growth of the industry is the lack of seed oysters. Oyster breeders depend solely on harvest sites for their supply.

A new technology based on Chinese hat collectors has developed in Northeastern New Brunswick. I will discuss: oyster landings from this sector; the technology used to produce seed oysters; and, finally, the industry's potential and ways of achieving it, with the use of this technology.

Overview

In New Brunswick, the largest percentage of oyster landings is from public beds and it varies between 700 and 800 tonnes annually. The Caraquet Bay public bed, with its 600 acres, produces up to 70 per cent of total landings, and Baie Ste-Anne produces another 14 per cent.

Two approaches were open to New Brunswick: either concentrate on public beds and, therefore, limit ourselves to a few sites, or promote the expansion of the private sector, favoring several inlets with oyster breeding potential. The decision to develop the private sector was made unofficially, to some extent, since, at the moment, there is no official development plan for the New Brunswick oyster industry.

Since the early 70's, efforts have been concentrated on the private sector. However, the development of the private sector has not been done to the detriment of the public beds. The latter are closely linked to the private sector, because of the technology used by New Brunswick oyster breeders.

Promoting the development of private beds means concentrating, on a mid- and long-term basis, on bays showing oyster cultivation potential, which involves up to 18 regions in New Brunswick. This will enable oyster breeders to contribute, on a long-term basis, to the development of the oyster industry in New Brunswick. This is the same approach taken by many European countries and a few American states, where the vitality of the industry is a result of the work of oyster leaseholders themselves. This makes for less dependence on the vagaries of nature in regard to the public beds, along with less dependence on the financial and human resources of government.

As I mentioned, New Brunswick had 842 oyster bed leaseholders, for a total of 4,080.6 acres under lease, and registered landings of 314 tonnes in 1985. However, according to reports from oyster breeders, only a few of the inlets are productive. Thus, 75 per cent of landings are from five bays, which are, in order of importance, Caraquet, with 90 tonnes; and Miramichi, Shippagan, Miscou, and Bouctouche with 61, 33, 29 and 21 tonnes, respectively.

It has also been noted that only 52 per cent of leaseholders report any production. This means that 48 per cent, who have no production, are contravening the oyster leasing policy, which states that they should produce at least 10 boxes of five pecks per acre.

Average production per leaseholder is 18 boxes of five pecks, for an average income of approximately $1,000 per owner. The production per acre under lease is even more modest, two boxes of five pecks. This is far from the potential production per acre suggested by Medcof, 200 boxes of five pecks, with multiple plantings. It should, nevertheless, be remembered that these production per acre estimates are averages, and that some oyster breeders have a much higher yield. It should also be pointed out that total production of 314 tonnes by the private sector is considerable, given the techniques used to obtain a supply of seed oysters and the fact that production comes mainly from five bays.

Why don't the holders of private leases use them to their potential? Why do only 52 per cent report some production per acre? Why is there no production in the 12 other bays, areas which are being leased for oyster cultivation?

The main reason given by leaseholders is the lack of seed oysters.

The owners of private leases depend on seed oysters from harvest sites to put their leases into production. Harvest sites are limited to a few bays and are insufficient to meet the oyster breeders' total requirements. These sites can only be approached at low tide. Oysters harvested by hand reduce the overall efficiency of oyster breeding, a disadvantage for leaseholders who hold other jobs during the summer. A large-scale seed oyster production technique was, therefore, necessary to meet the needs of leaseholders.

Technology

In 1979, a development plan was prepared with the principal aim of developing a technology to produce seed oysters for private leaseholders and to promote the establishment of a group of producers specializing in seed oysters for breeders in the inlets where the production of seed oysters is impossible.

Several studies have been undertaken since 1979, which have led to the development of five oyster production strategies. Each involves several levels of work for the oyster breeder. The strategies are based on the use of Chinese hat collectors.

The first stages -- liming, collecting, wintering and off-bottom growth -- are common to the various strategies. After that, the oyster breeder must make a choice for the threshing of the spat from the collectors: separate them immediately or wait until after one complete summer of growth or a second winter. After threshing, the oysters must either be spread on the bottom of a bed, grown suspended or placed in the inter-tidal zone. Also, the type of planting must be decided upon, either separate or multiple. The last two steps are upkeep and harvesting. The oyster breeder must define, in his operational plan, which strategy he will be using, as his choice will affect the work and the equipment required.

First of all, the oyster breeder assembles his collectors. In New Brunswick, we use Chinese hats, a cone-shaped collector having an area of 1,800 sq.cm. The surface of a column of 12 Chinese hats is comprised of 49 wood rings or 24 shell strings. These collectors, at a cost of $21 each, are assembled during the winter or spring to allow time for liming. The number of columns assembled depends on the number of seed oysters required and the extent of collection in the area where the collectors are set.

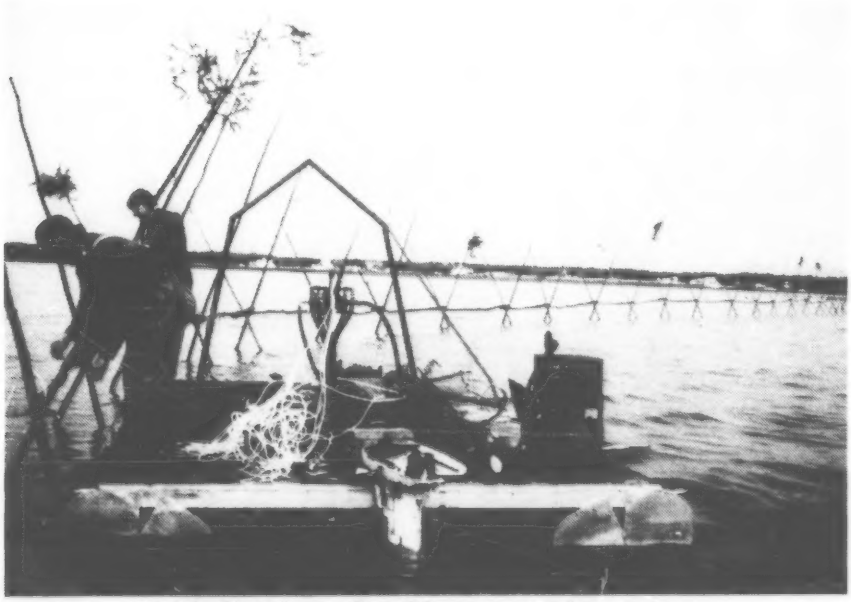
Chinese hats

For example, if the average number of oysters separated from a collector is 3,000, that is 14 oysters per 100 sq.cm. If the oyster breeder wants to plant 200,000 oysters annually, for a final production of 200 boxes of five pecks, he will, therefore, need 67 columns.

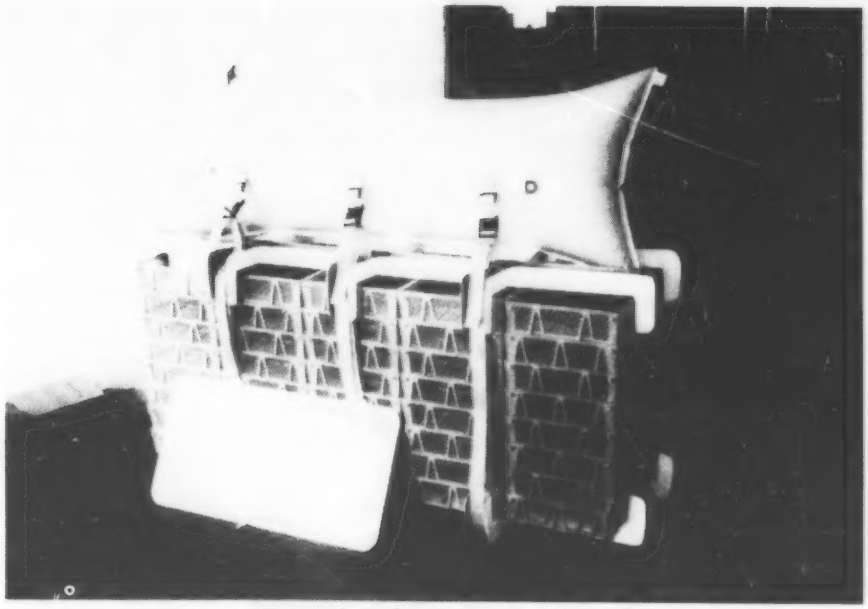
The columns of Chinese hats must be limed before being placed in the water. The mix covering the plastic collectors is comprised of equal parts of cement, lime, sand and water. The collectors are rolled in this mix until they are covered by a 2 mm thick layer. Five people can lime 500 columns in a day. It takes a 40-kg bag of cement and a 23-kg bag of lime to cover between 15 and 18 columns of Chinese hats.

The columns are then drained and stored in a shed to allow them to dry slowly. After four days, they are taken outside so that the mix can harden and the rain can wash off any remaining particles. The Chinese hats should be left outside for at least two weeks before spat collection.

The collectors are now prepared for placement on fences. These are usually made of spruce poles to which the columns are attached. Using buoys to support the columns has many advantages. Long lines can be prepared in advance and set up the week before collection begins. In addition, another piece of equipment is now available, the "omer" cultch boom. This boom, made up of inflatable cylindrical balloons, sells for $90 and holds six columns. The advantage to this system is that before winter, the air is removed from the balloons and the columns sink to the bottom, safely away from the ice. In the spring, the air is pumped back into the balloons and the line comes back to the surface. The disadvantage is the initial investment, which comes to approximately $2,000 for a 120-column enterprise.



Installation of Collectors Using Fences



"Omer" Cultch Boom (above)

A third method involves placing the collectors on a metal frame. This allows the oyster breeder to put the columns back after collection. The oyster breeder must assess which technique is most appropriate for his operation.

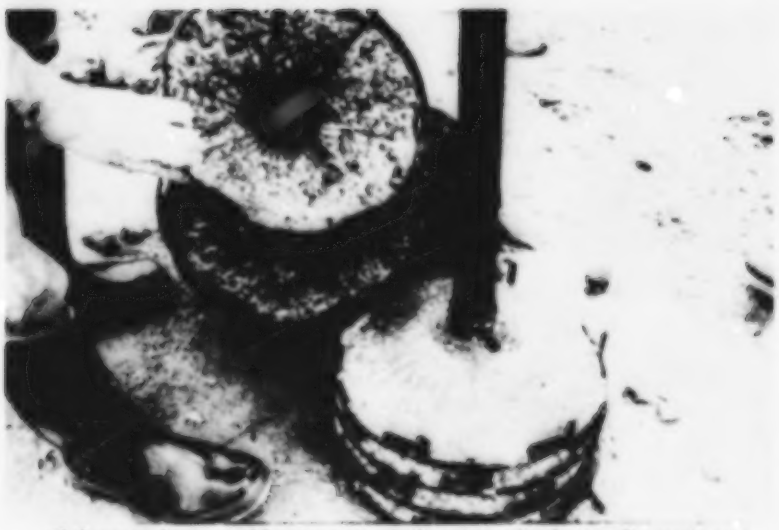
He also has to wait for the proper moment to put his collectors in the water, when the spatfall is greatest or most commercially profitable. In New Brunswick, spatfall prediction has been done by a Fisheries and Oceans technician and, later, by a contract employee. Since the summer of 1986, we have been experimenting with transferring this service to the industry. The method used is the following: 1) recording the water temperature, 2) the evolution of the gametogenesis, 3) measuring the growth of the larvae, 4)

checking the start of collection, and 5) determining the date of commercially profitable collection. At that moment, oyster breeders must immediately put their collectors in the water. They usually put them out 30 cm from the bottom so as to prevent predation by crab and starfish.

Most oyster breeders in the northern part of the province collect their oysters from Caraquet Bay. The collectors are then transported to their own leases a month after collection.

The collectors are left suspended until October or whenever the water temperature falls below 9°C. The size of the oysters can then vary between five and 20 mm, depending on the inlet, the density and the year. Next the collectors are transported to wintering sites. These sites must have a firm bottom and a minimum depth of 145 cm to protect the collectors from the ice. By April or May, depending on when the ice melts, the collectors are put out again. This must be done as early as possible to take advantage of the proliferation of spring algae. However, care must be taken to avoid exposing the oysters to fresh water on the surface caused by melting snow or spring rains.

The Chinese hats are left out until June or September, depending on the strategy used. After a complete summer's growth (14 months after collection), the oysters on the collectors are about 25 to 30 mm in size. It is important that seed oysters be at least this large before being planted on the bottom. Rock crab can eat up to 4.5 oysters of less than 30 mm daily. They can also be dragged away by the current or buried under sediment. The survival rate is, therefore, increased by complying with the 30 mm minimum.



Chinese hat collectors with attached seed oysters

Oysters of this size are then removed from the collector, a step called threshing. The oyster breeder can manually remove up to 25 columns of Chinese hats per day by removing and folding each Chinese hat, one by one. This practice is recommended for businesses having 100 columns of Chinese hats or less. A threshing machine is available for larger operations.

With such a machine, an oyster breeder, with two assistants, can remove the spat from 25 columns per hour. The operating principle is simple. A column is inserted into the threshing machine between three rollers, the cover is pulled down over the column and a handle is pulled. The pressure on the column from the three moving rollers makes the cement on which the oysters are attached fall off into a container. This machine, developed in northern New Brunswick, is available for about $3,000. It would be even more economical if a group of oyster breeders were to share one.

The next step is very important for the success of an oyster business, spreading the seed oysters.

For a few thousand seed oysters, spreading is done with a shovel. For a larger quantity, a mechanical spreader is used. The mechanical method is more rapid and efficient. The seed oysters are poured into a hopper and drawn up on a conveyor belt to fall on a rotating paddle. The oysters are spread over a width of 3.7 meteres. An oyster breeder who has properly marked the surface to be planted can spread up to 300,000 oysters in an hour. The spreader can be shared by a group of breeders to reduce the cost, which is between $500 and $1,000. A certain minimum quantity of oysters must be planted, depending on the type of seeding and the yield desired per acre. An annual mortality rate of 10 per cent is to be expected so with a separate planting method, an oyster breeder aiming for a yield of 200 or 300 boxes of five pecks will have to spread 200,000 and 300,000 oysters respectively.

With these seeding rates, the harvest density is between 30 and 45 oysters per square meter. This represents a density (coverage per acre) of 13 to 20 per cent. From a physical point of view, this seeding density is not excessive and is recommended. However, the oyster breeder must check the condition of his oysters regularly to prevent mortality caused by exceeding the biotic capacity of the environment.

Mechanical Spreader for Seed Oysters

As already mentioned, oysters of less than 30 mm are vulnerable to predation by crab. Two methods may be used to reduce this threat. Modified whelk traps are effective, but non-selective, which prevents us from using them. Tests are planned for 1988 to find a trap that will let lobster escape, but which will retain crab.

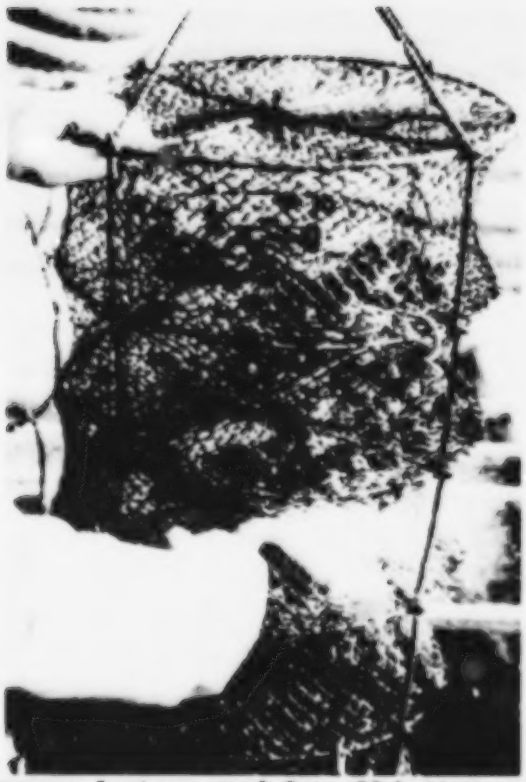
A second method is the anti-predator board. This board is used to remove sedimentation on the bottom and on the oysters. The wash created by the inclined board, when pulled along the bottom, stirs up the crabs, which are caught by the net. The effectiveness of this method, developed in the United States, has not yet been clearly proven in New Brunswick.

Oysters must remain on the bottom for five or six years in order to reach market size. Raking must, therefore, be done to insure improved survival, growth and quality. Two types of rakes have been developed, but they do not entirely meet our needs. Other tests are planned for 1988.

The final step before marketing is harvesting. This is done by dragging, using various types of vessels. The drag and vessels used have also evolved to meet the needs of the expanding oyster industry.

There are, then, two strategies currently used in New Brunswick. The first stages are quite well developed. What now remains is to experiment with predator control, raking and harvesting.

The third and fourth strategies differ from the first two because of the steps taken after threshing. Oysters having an average length of 30 mm are placed in containers to be grown off-bottom or in the inter-tidal zone. With this method, the time required for the oysters to reach market size is reduced by one year, and the survival rate is increased. The third strategy is based on the use of Japanese lanterns for off-bottom growth or pens. A density of 500 oysters per compartment is recommended, and they may reach an average size of 45 mm at the end of the second year, compared with 36 mm on the bottom.



A Japanese lantern used for off-bottom growth

With the fourth strategy, 1,000 oysters are placed in the inter-tidal zone in bags of 3,800 sq.cm. These oysters are then planted on the bottom in the autumn, leaving the bags free for other recently-threshed spat.

The fifth strategy constitutes the second phase in the development of the oyster breeding industry in New Brunswick, the development of seed oyster producers. In 1985, two seed oyster producers were given the mandate of producing 6 million oysters each to sell to 20 oyster breeders working in inlets that have no collection potential.

How could this objective be reached? The first steps are the same as with the other strategies we have seen. The difference occurs at the threshing stage. This is done in June or early July, when the oysters are a minimum size of 10 mm. Threshing the spats from the collectors at this date ensures a greater survival rate and leaves the collectors available for the next collection. To reach a production of 6 million oysters, a minimum of 1,250 columns is needed, or in other words, 5,000 oysters per column or 23 oysters per 100 sq.cm., upon threshing. The oysters are placed in pens or floating tables. The pens are made up of 100 intertwined baskets forming 10 rows of 10 baskets. A pen has a capacity for 100,000 oysters; therefore, a producer needs 60 to grow his 6 million oysters. These pens, at a cost of $1,000 each, are not yet in widespread use in New Brunswick.

Floating tables are used by producers located in the northeast. These tables, constructed by the seed oyster production company, can hold 29,400 oysters.

After a summer's growth, oysters are sold when they reach a size of 30 mm. Under this program, the oyster breeders buy 600,000 oysters at $9.70 per 1,000 units to seed each two acres. After five years, a production of 300 boxes of five pecks per acre, or 54,000 lbs, can be expected. Therefore, within six years and, with 10 new oyster breeders, private sector production could double to 559 tonnes, generating revenues of more than $1 million for oyster breeders.

Potential

With the success of the seed oyster production companies and the production of seed oysters by oyster breeders themselves, landings in New Brunswick will rise. The private sector production potential in New Brunswick, using Medcof's estimates, comes to 33,381 tonnes. Even with a more conservative approach, production potential would be about 8,000 tonnes with a yield of 12 tonnes per acre every six years, providing oyster breeders with economic benefits of $10,560,000.

These figures do not take into account the biotic capacity of the environments under cultivation, the quality of the substrate and the willingness and ability of oyster breeders to invest in their companies.

Under the agreement on fisheries signed with New Brunswick (ERDA), a program has been set up to encourage oyster breeders to meet their own seed oyster requirements through the purchase of Chinese hat collectors and growing equipment. Another provides financial encouragement both to the two seed oyster producers and to the oyster breeders who buy the seed.

We are also carrying out an inventory of oysters in the inlets of eastern New Brunswick. We will map the distribution of the existing resource, the type of bottom and the physico-chemical conditions which exist (temperature, dissolved oxygen, ph level, salinity, chlorophyll and flow). The results of this inventory will enable us to better identify the development potential of the oyster cultivation industry in the province.

THE STATUS OF BELON OYSTER CULTURE IN NOVA SCOTIA

by

Dr. Catherine Enright

National Research Council

Atlantic Research Lab

Dartmouth, Nova Scotia

The European Belon oyster, Ostrea edulis, is currently being cultured on the Atlantic coast of Nova Scotia. This species was introduced to Atlantic Canada in 1969 by Roy Brinnan, Department of Fisheries and Oceans, from stocks which originated in Holland. Belon oysters were intended to thrive only on the Atlantic coast, in areas unsuitable for the native oyster, Crassostrea virginica. Thus, Belon oysters do not compete with C. virginica, but enable the region to produce two quality oyster species for domestic and export markets. While under quarantine conditions, a genetic selection program was conducted by Drs. L. Haley and G. Newkirk of Dalhousie University. Juvenile Belon oysters were produced for outplanting on coastal Atlantic aquaculture sites in the summer of 1979. From this, a Nova Scotian Belon European oyster industry has developed; several small Nova Scotian aquaculture companies are now selling their oysters in Halifax and Toronto. I will present an update now on where we stand and on the problems we've had along the way.

The major problem that we've had with the industry has been in the hatchery. There have been problems in spawning the oysters, and there hasn't been a good source of seed for the past two years. This, of course, has led to other problems, because there are many people who are interested in growing Belon oysters; in Nova Scotia alone, I have a list of 15 people who are very interested. However, because of the problems with seed supply, there has been a slowdown in the development of the industry.

This coming year, we are going to try again to produce the Belon oyster. We believe that a large part of the problem has to do with the water temperature of the ocean. We were trying, originally, to spawn animals that had been subjected to very harsh winter conditions. The following year, we took better care of the oysters and made sure that they were maintained throughout the winter at a more favorable temperature. This seemed to help somewhat, but we were still not able to get the yields that were needed.

Last season, the industry made use of a hatchery in National Research Council facilities, and we ran into, what we believe to be, metal toxification problems. The system we used was 20 years old and, when spawning the animals, we were introducing contaminants through copper piping and a variety of other connections in the old system. So, this year we are going to try again, with a new facility, a new system, avoiding the problems of copper toxicity, and we hope we'll get the seed supply we need in order to satisfy demand.

We are producing the Belon oyster without having our own hatchery because of economics, the requirement for capital. The main reason for this is that we don't have a sheer technology at present and, therefore, it's very hard to interest the venture capital people.

In terms of marketing, we've met with overwhelming success in having people, including wholesalers and restauranteurs, respond to the Belon oyster. Our problem, of course, is that we don't have the level of production to satisfy demand. We've received telephone calls from Dallas, California and, even Vancouver. The one problem we have had in marketing Belon oysters, however, is that the wholesalers and the retailers don't want to deal with just one product, and they don't want to deal with just one oyster product. We hear this time and time again from the people we are dealing with. As soon as we begin marketing our oysters, they want to know

where the Malpeque oysters are. They want to be able to market both of them, side-by-side, using the same channels, so that a given restaurant owner will have a variety from which to choose.

We would, therefore, like to see Malpeque oysters and Belon oysters marketed through the same channels. We are dealing with a gourmet product that would be an hors d'oeuvre in an exclusive restaurant. This is where the highest prices can be obtained, and the demand is certainly there. We conducted a market study for both the Belon and the Malpeque oyster and found that the demand was extremely strong in Quebec City and Montreal, especially during the Thanksgiving, Christmas, and New Year's periods when there are very few competing oysters available. This has traditionally been a strong market. The results of our study tell us that marketing is not going to be a problem, epecially if we can provide what the wholesalers and the retailers want. And that would be two very good Atlantic Canada products.

The same results were obtained doing a market study in Europe. The demand for both oyster species was very strong, but the Belon was stronger than the Malpeque. Here again, however, they wanted to offer as many oyster species as were available. Because of disease in Europe, there are very few oysters on the market at present, and it's just a matter of filling the gap that exists there.

The comparative price between Malpeque and Belon oysters will be a function of the market situation. In Europe, there has always been a strong demand for the Belon, and Europeans are prepared to pay a higher price. This is not necessarily the case in Nova Scotia or in North America generally, so it is a function of location.

In the past, the hatchery price for seed has been in the $16 to $18 per thousand price range. The problem with the price is that we never really had good numbers, and we never had several years' production in order to determine what the price should be. Right now, we are using $16 to $17 per

thousand, and I expect that will be maintained until we have production in such numbers that we can drop the price and still be viable, but it will probably not drop very much. A lot of this is speculation, of course, because we are unsure of the production levels and the demand.

In determining if they can be grown profitably, the type of culture makes a big difference. Whether they can be finished off using bottom culture or whether they have to be produced in lantern nets and purloten nets for the entire period of development will make a difference. From the numbers we have generated, it appears that the Belon oyster, once we take into account equipment costs and labor, can be grown profitably, if bottom culture is used.

PUBLIC OYSTER BED ENHANCEMENT

by

Clyde L. MacKenzie, Jr.

Sandy Hook Laboratory

High Lands, New Jersey

Virtually all the oyster production in the Eastern United States stems from natural sets. To maintain stocks, many states have spread shells on setting beds to provide a substrate for oyster larvae. For instance, in 1986, these states spread the following quantities of shells: Virginia, 2 million bushels (it is now trying to appropriate more money for shells); Maryland, 5.5 million bushels of dredged shells and 300,000 bushels of shucked shells; New Jersey, 330,000 bushels of dredged shells; and Conneticut, 750,000 bushels of dredged shells.

Despite these efforts, oyster production has declined due to a long-term drought. Thus, the disease MSX and the oyster drill have penetrated much further up estuaries, killing oysters in areas where they had survived in previous years. A return to normal rainfall, however, should mean a return to earlier survival rates and production levels.

Aside from shell plantings, states do little to enhance the productivity of public oyster beds. Shellfish production specialists are needed to do that job. The specialist would examine seed beds with SCUBA, identify factors which limit oyster production, and develop cost-effective measures to control those factors. My colleagues and I have found that most oyster setting beds have been affected by environmental factors which limit oyster abundance. We feel environmental improvement is feasible at low cost.

Allan Morrison (Fisheries and Oceans) and I worked as shellfish production specialists on Prince Edward Island in 1972-73. Before then, nothing had been done to improve oyster productivity. We initiated the province's first large-scale public bed enhancement. It involved: (1) relocating oysters from areas where fishing was not possible to potentially good fishing areas which had previously been barren; (2) mining fossil shells (about 20,000 boxes a year); and (3) desilting shells in good setting areas. The result has been nearly a four-fold increase in oyster production on the Island. In 1985, total revenue from the program had risen to $1.4 million a year. The original cost of the program was only $190,000.

I have been acting as a shellfish production specialist in Delaware Bay (New Jersey) since 1986. The industry there is very depressed. In 1955, 850,000 bushels of oysters were produced. That total fell to only 35,000 bushels in 1985. We found that: (1) the shells on the beds were heavily silted, (2) about one-third of the beds had too few shells to collect a set, and (3) about 70 per cent of the oyster spat on the lower seed beds died from the predations of oyster drills and mud crabs.

In 1986, we plan to: (1) determine the extent of smothering mortality among oysters in silt in the spring, (2) wash silt off some of the beds to increase the setting densities of spat, and (3) transplant seed from the upper seed beds to the lower seed beds to determine whether they survive. In addition, we will look for other ways to enhance oyster abundance. As well, we and the industry devised a management plan in which oysters would be marketed directly from what are now the lower seed beds.

The management plan we are recommending is to: (1) wash silt off shells to enhance setting, (2) move oysters from the upper seed beds to the lower seed beds, and (3) spread shells on the upper seed beds.

QUESTIONS RAISED DURING THE DISCUSSION PERIOD
on
OYSTER CULTURE

The following points were raised during the discussion period which followed the presentations on oyster culture:

- oyster lease requirements (P.E.I.);
- the Belon oyster;
- the siltation problem.

OYSTER LEASE REQUIREMENTS (P.E.I.):

A person who applies for a lease in P.E.I. doesn't have to submit a plan. The problems, the expense, the type of operation being undertaken, and possible conflicts are discussed in order to make an applicant aware of the situation he is getting into. But this may be inadequate. Participants felt an applicant should have to submit a plan in writing with objectives which must be met in order to keep the lease. Probably 85-90 per cent of the Island leases are not being utilized to any great extent, and of those which are, only about 1 per cent are reaching their potential. This screening process might change that.

THE BELON OYSTER:

It takes three or four years for the Belon oyster to reach maturity. Fast-growing oysters reach marketable size within three years. Others need four years. In growing Belon oysters, the off-bottom method is used during the first and second years; they are maintained in pearl or lantern nets. They are also sometimes left in lantern nets for the third year. They are

usually bottom-cultured during the fourth year in order to thicken their shells and create firmer oysters that are easier to open. Belon oysters usually begin to spawn in January and February, and the oysters are kept in the hatchery for two or three months after that. About the third week of June, the animals are taken from the hatchery and placed on oyster farms.

THE SILTATION PROBLEM:

Oysters can handle a great deal of silt without suffocating. In the winter, however, the oysters are not pumping and become covered with silt. This has been a problem in Delaware Bay where there is a lot of siltation and very little wind. Mortalities of 90 per cent after two years have been reported. This only occurred in the winter, when the oysters were dormant. On Prince Edward Island, before enhancement programs got underway, 40-50 per cent of oysters were choice. After the spreading and de-silting program, 80-85 per cent of oysters are choice because they are grow on a hard substrate above the silt level.

RAPPORTAGE
OYSTER CULTURE

by

Ray Gallant

Current oyster production -- about 5 million pounds -- is concentrated in the southern Gulf of St. Lawrence and is directed at the half-shell trade. This output is approximately one-third of the historical maximum; the immediate objective of the industry is to again produce around 15 million pounds annually. This will be achieved through:

1. the enhancement of public beds; and

2. the development of private leases.

At issue is which of the two methods is preferable in terms of cost, probability of success and level of public assistance required. Also at issue is the effect on quality of bottom versus off-bottom collection of spat. The related questions of off-bottom rearing techniques and the pros and cons of the various methods of spat collection came in for considerable discussion.

Presentations also revealed concern on the part of the growers over property rights, protection of inventory, site availability and shared jurisdiction (federal and provincial) and the impact this might have on regulation and development.

Several presentations provided a clear reminder that new technologies are constantly being introduced and commercialized. Producers must keep abreast of these developments, and this information should be made available to them through effective technology transfer activities.

THE CULTURE OF QUAHAUGS

by
Richard Kraus
Aquacultural Research Corporation
Dennis, Massachusetts

The Aquacultural Research Corporation (ARC) is working on the culture of the quahaug from fertilized egg to mature, highly-marketable shellfish.

ARC is a private, profit-making company whose objective is to commercialize shellfish farming in our region of the United States. At ARC, we have experience in the culture and growout of the quahaug, American oyster, bay scallop and sea or surf clam. Based on our experience, it is the quahaug which, at least initially, lends itself most readily to shellfish farming. It is a relatively hardy species which can and does adapt to wide ranges of environmental stress, ranging from baking in the summer sun on intertidal flats to being buried under 4 feet of ice during the winter months. It is remarkably disease-free and is fairly predator-free, once grown to 20 mm in size. Mature, it lends itself well to harvesting, holding and shipping, and, most importantly, enjoys wide acceptance in the marketplace and commands a price rivalling the best oyster in the half-shell trade.

During 1986, we harvested and shipped to market 5,000 bushels of little-neck clams, or more than 2.5 million mature quahaugs. These quahaugs were harvested from an area of slightly less than 2 acres of intertidal bottom.

Quahaug culture to market size, as practiced at ARC, is a process involving three distinct phases:

1. the hatchery phase of growout, from fertilized egg to 6 mm size;

2. a nursery phase of field growout (from 6 mm to 20 mm); and

3. a bottom growout phase (20mm to market size, roughly 48 to 52 mm).

The hatchery phase is the most critical and demanding of the three.

In order for quahaug growout culture to work, 6 mm seed must be available from the hatchery during the early spring. This dictates that seed be grown during the time of year least conducive to hatchery operations. Raising significant quantities of seed during the winter months requires that large quantities of seawater be heated to 18 - 20°C and that a micro-algae food source be cultured in large quantity under the most adverse conditions. At ARC, our seed production system requires that we culture virtually all of the seed quahaug micro-algal food source. To do this, half the hatchery staff and budget is dedicated to micro-algae culture.

Over the past 10 years, we have developed an algal facility that routinely and consistantly delivers 20,000 to 40,000 litres per day of algae culture at densities averaging 2×10^{10} cells per litre. Both artificial light and heat, derived from salt water wells, are necessary for our algae culture system to function properly.

The culture of the quahaug from fertilized egg through 6 mm size is relatively straight-forward on a small scale. Culture techniques were developed during the early 1950's by Lousenoff and Davis, and the same basic practices remain in use today. Complications occur when these methods are scaled up to commercial levels, and must meet those economic demands. At our hatchery, we are geared to raise between 8 and 10 million of 5 to 6 mm seed for delivery to our field operations in May and early June. This seed supplies not only our own field plants, but those of many growers who have come to depend on us.

It is imperative to the economic viability of any field growout scheme that seed stock grows to market size quickly and uniformly. The seed produced at ARC, given a good field growout site, will attain market size (50 mm) within 24 to 30 months following field planting. Natural seed and stock from other hatcheries take from 50 to 100 per cent longer to reach market size under identical conditions. The implications of this longer growout period are many, including much higher initial capital cost, increased maintenance cost and greater risk associated with the stock being exposed to the vagaries of nature for longer periods. You should not underestimate how important fast-growing stock is to the success of any growout enterprise involving quahaugs. The growth rates of ARC stock are the result of two factors: one is our selective breeding program that has been ongoing for more than 10 years and the second is culling in the hatchery which ensures that slow-growing seed stock is discarded.

During the early years of our breeding program, a shell coloration, a brown zig-zag or stripe, known as a "notata varient" in the normally white-shelled quahaug, was bred into our brood stock. This distinctive marking normally occurs in less than 1/10 of 1 per cent of our northern stocks of wild quahaugs. Our breeding program has produced this shell marking on 80 per cent of all seed leaving the ARC hatchery, and serves to readily identify the seed as being of cultured origin.

CLOSING REMARKS

by

Yves Tournois

Director, Atlantic Fisheries Development Branch

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Closing remarks are always hard to fine tune to the appropriate level. Today, it is an almost impossible task! There is no way that my closing remarks can approach the level of excellence demonstrated by the speakers at this Workshop.

I will, therefore, limit my intervention to an expression of appreciation on behalf of the Department, in the Gulf Region and in Ottawa.

I would like to thank Dave Morgan of Holland College and the Organizing Committee for setting the stage which allowed the Workshop to be so successful.

I want to thank the speakers who have shared with us their experience, their knowledge, and their vision of the many facets of an industry which, in the words of Tom Hayes, has "come of age".

I want to thank the moderators who maintained a very tight schedule. They did it with such skill that participants did not lose the opportunity to express their concerns through discussion and comment.

I also want to thank the people behind the scenes. The translators, who were reduced in number because of the storm, performed excellently. The people at the registration desk carried out their responsibilities in an efficient and courteous manner. And finally, I want to thank all participants. This was your Workshop. We provided a spat, but you made it grow. Thank you all very much.

APPENDICES

Appendix A

ATLANTIC AQUACULTURE WORKSHOP
FEBRUARY 9 - 12, 1987

AGENDA

EVENING

MONDAY, FEBRUARY 9, 1987

18:00 - 21:00 Registration
19:00 - 21:00 Reception (Hosted by the P.E.I. Department of Fisheries)

DAY 1

TUESDAY, FEBRUARY 10, 1987 (MORNING SESSION)

08:00 Registration
09:00 Plenary Session
- Welcome
- Opening Remarks

SALMONID CULTURE

Moderator: S. Campbell

09:30 Precis of Salmonid Culture in Europe
- P. Hjul
09:50 A Case History of an Atlantic Salmon Farm
- J. L'Aventure
10:10 Discussion
10:20 BREAK
10:35 Seed Stock Supply
- Dr. Dave Scarratt
11:00 Discussion
11:10 Demonstration Salmon Farms
-Cage Culture
- G. Henderson
-Landbased Culture
- R. Biggs
11:50 Discussion

OYSTER CULTURE

Moderator: J. Campbell

09:30 Precis of Atlantic Oyster Industry
- J. Jenkins
09:50 Public Bed Enhancement Enhancement
- C. MacKenzie,Jr.
10:30 Discussion
10:45 BREAK
11:00 Private Lease Development
- E. Ferguson
11:45 Discussion

12:00 LUNCHEON
Dr. R.G. Thompson, Dean, AVC
"The Atlantic Veterinary College and Aquaculture"

TUESDAY, FEBRUARY 10, 1987 (AFTERNOON SESSION)

FISH HEALTH

Moderator: G.R. Johnson, D.V.M

13:30	Fish Health & Disease Control - J. Cornick
13:50	**Discussion**
14:00	Water Quality - E. Mason
14:20	**Discussion**
14:30	Nutrition - Dr. C.Frantsi
14:50	**Discussion**
15:00	**BREAK**
15:15	Histology/Pathology - Dr. B. Hicks
15:35	**Discussion**
15:45	Immunization - Dr. W. Patterson
16:05	**Discussion**
16:15	Parasitology - Dr. S. MacGladdery
16:35	**Discussion**
16:45	Rapportage

OYSTER CULTURE

Moderator: A. Morrison

13:30	Status of Belon Oyster Culture in Nova Scotia - Dr. C. Enright
13:50	**Discussion**
14:00	Leasing Policy/River Designation System - J. Jenkins
14:30	**Discussion**
14:45	**BREAK**
15:00	Marketing and Packaging - Dr. C. Enright - E. Ferguson - J. Jenkins - C. MacKenzie
15:45	Quahaug Culture - R. Kraus
16:15	**Discussion**
16:30	Rapportage

19:00 **WORKSHOP BANQUET**

Peter Hjul, Editor, Fish Farming International

'International Aquaculture'

DAY 2

WEDNESDAY, FEBRUARY 11, 1987 (MORNING SESSION)

	SALMONID CULTURE		MUSSEL CULTURE
Moderator:	L. Murphy	**Co-ordinator:**	T. O'Rourke
08:30		08:30	Mussel Culture Field Trip
09:00	Overwintering - L. Murphy		
09:20	Kelt Reconditioning - R. Grey		
09:40	Salmonid Biotechnology - Dr. B. Glebe		
10:00	Non-Salmonid Cultures - P. Hjul		
10:20	**Discussion**		
10:30	**BREAK**		
10:45	Marketing and Promotion - Panel - G.W. Wolfe - R. Robillard - W.L. Mockbee		
11:45	Rapportage	11:45	Return from Field Trip
12:00	**LUNCHEON**		

WEDNESDAY, FEBRUARY 11, 1987 (AFTERNOON SESSION)

SALMONID CULTURE		MUSSEL CULTURE	
Co-ordinator: L. Murphy		Moderator: I. Judson	
13:00	Salmonid Culture Field Trip	13:00	Opening Remarks - B. Rowat
		13:15	Precis of Mussel Culture - I. Judson
		13:30	Culture Biology of Mussels - B. Myrand
		14:00	Discussion
		14:15	Leasing Policy/River Designation System - J. Jenkins
		14:45	Discussion
		15:00	BREAK
		15:15	Culture Techniques - Spat Prediction - J. Campbell - Site Selection - Dr. A. Maillet - Intensive Culture & Productivity - W. Somers
		16:00	Discussion
16:30	Return from Field Trip	16:30	Rapportage - M. Mallet

19:00 - 22:00 Informal Sessions with Resource Persons

DAY3

THURSDAY, FEBRUARY 12, 1987 (MORNING SESSION)

MUSSEL CULTURE

Moderator: R. Drinnan

09:00 Predation, Disease, Mortality
- P. Darnell
- Dr. A. Maillet
- Dr. R.J. Thompson
- G.R. Johnson, DVM

10:00 Panel Discussion

10:45 **BREAK**

11:00 Aquaculture: An Investor's Point of View
- T. Hayes

11:20 **Discussion**

11:30 Cash Flow Management
- D. Walsh

12:00 **Lunch**

THURSDAY, FEBRUARY 12, 1987 (AFTERNOON SESSION)

13:30 Mussel Processing for the Market
- Dr. R. Ablett

13:50 **Discussion**

14:00 Air Transport of Live Shellfish
- A. Rach

14:40 **Discussion**

15:00 **BREAK**

15:15 Marketing of Fresh Product - Panel
- R. Dockendorff
- I. Kerry
- R. Robillard
- P. Darnell
- D. Walsh

16:00 Rapportage
- M. Mallet

16:15 Closing Remarks
- Y. Tournois

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NATIONAL POLICY GOALS FOR CANADIAN AQUACULTURE
(June 9, 1986)

To date, all the provinces and the territories, as well as the federal government, have had various measures to encourage commercial aquaculture development in Canada. Future development will be achieved through the combined efforts of industry and government working towards common goals. These goals embrace the following:

(i) TO ENCOURAGE THE DEVELOPMENT OF COMMERCIAL AQUACULTURE IN CANADA IN A MANNER THAT IS COMPLEMENTARY TO THE CONTINUING DEVELOPMENT OF THE WILD FISHERY;

(ii) TO INCREASE THE ECONOMIC RETURNS FROM INTENSIFIED PRODUCTION AND HARVEST OF HIGH VALUE, MARKETABLE SPECIES OF FIN FISH, SHELL FISH AND MARINE PLANTS IN THE REGIONS OF CANADA;

(iii) TO IMPROVE THE QUALITY AND EXPAND THE VARIETY OF CANADIAN FISH PRODUCTS;

(iv) TO IMPROVE THE RELIABILITY OF SUPPLY OF CANADIAN PRODUCTS TO BE MARKETED IN CANADA AND ABROAD;

(v) TO CREATE NEW EMPLOYMENT AND ENRICHED INCOME OPPORTUNITIES IN THE PRODUCTION OF FISH;

(vi) TO ENCOURAGE LONG-RANGE STABILITY IN THE COUNTRY'S FISH PRODUCTION SECTOR THROUGH DIVERSITY AND CONTINUITY OF SUPPLY; AND

(vii) TO PROMOTE THE DEVELOPMENT AND APPLICATION OF THE MOST ADVANCED TECHNOLOGIES FOR INTENSIVE PRODUCTION AND MARKETING OF FIN FISH, SHELL FISH AND MARINE PLANTS ACROSS CANADA.

In pursuit of these goals, the following **basic principles** have been adopted:

(i) THE PRIVATE SECTOR SHOULD BE RELIED UPON TO ESTABLISH AQUACULTURE VENTURES AND TO MARKET THE RESULTING PRODUCTS TAKING ADVANTAGE OF EXISTING STRUCTURES WHERE APPLICABLE;

(ii) THE FEDERAL GOVERNMENT AND THE PROVINCES/TERRITORIES SHOULD CO-ORDINATE THEIR EFFORTS TO ENSURE THE ORDERLY DEVELOPMENT OF COMMERCIAL AQUACULTURE IN CANADA;

(iii) MEMORANDA OF UNDERSTANDING TO PROMOTE COMMERCIAL DEVELOPMENT SHOULD BE ENTERED INTO A BILATERAL BASIS SO AS TO RECOGNIZE REGIONAL DIFFERENCES;

(iv) THE REGULATORY FRAMEWORKS OF GOVERNMENTS SHOULD BE CLARIFIED FOR COMMERCIAL AQUACULTURE DEVELOPMENT;

(v) GOVERNMENT PROGRAMS SHOULD PROVIDE SUPPORT TO THE AQUACULTURE INDUSTRY IN SOME KEY STAGES OF DEVELOPMENT;

(vi) THE FEDERAL GOVERNMENT SHOULD CONTINUE TO MAINTAIN A RESPONSIBILITY FOR FISH HEALTH IN GENERAL, INCLUDING ALL CULTURED SPECIES;

(vii) CONTINUING DIALOGUE BETWEEN THE AQUACULTURE INDUSTRY AND GOVERNMENTS SHOULD BE ENCOURAGED; AND

(viii) IN ORDER TO IMPROVE THE TECHNOLOGICAL BASIS FOR COMMERCIAL AQUACULTURE, GOVERNMENTS SHOULD WORK CO-OPERATIVELY WITH INDUSTRY IN PROMOTING AND CONDUCTING R & D AND TRANSFERRING THE RESULTING BENEFITS.

Appendix E

The complete text of David Walsh's presentation was not available on the date of publication. An abstract has, therefore, been prepared for presentation here.

PRECIS
CASH FLOW MANAGEMENT
by
David Walsh
Atlantic Ocean Farms
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The Cash Flow Sheet is the most important financial statement required by potential investors. Its chief function is to budget inflows and outflows of cash on a short-term basis. It is used to quickly compare actual financial status with projected figures. A mussel farmer must identify income, expenses and investor requirements. He must develop a realistic financial plan that includes conservative income projections balanced against liberal expense projections. A list of over 40 possible expenses is included for consideration.